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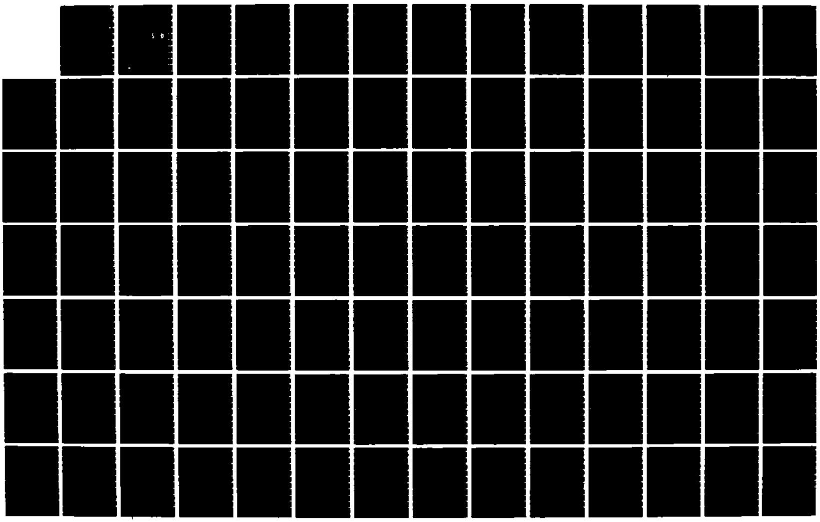

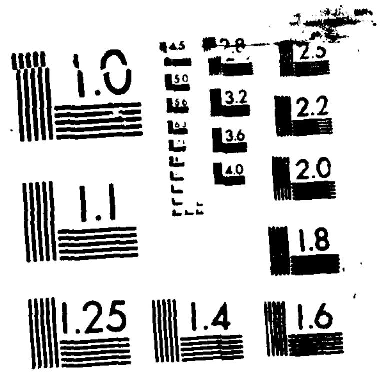

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FORMULATION OF NUMERICAL METHODS
USED IN THE
XYZ THREE-DIMENSIONAL POTENTIAL FLOW PROGRAM

An Engineering Report

by

WILLIAM JAMES BEARY JR.

N00228-85-G-3303

Submitted to the Faculty of
the College of Engineering
Texas A&M University

in partial fulfillment of the requirements for the degree of

MASTER OF ENGINEERING

May 1986

Major Subject: Ocean Engineering

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Allen H. Magnuson

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ABSTRACT

The calculation of non-lifting potential flow about arbitrary three dimensional bodies is examined in detail with specific interest in the XYZ Potential Flow program developed by the David W. Taylor Naval Ship Research and Development Center. The program uses a surface singularity distribution to solve the Neumann boundary value problem by means of a source panel method assuming a flat element with a constant source density over the area of the element. Boundary conditions are applied at control points on the elements producing a system of linear equations for the source density. When the source density is known, velocities and pressure coefficients may be calculated.

The main purpose of this paper is to present the details of the approximation of an arbitrary three dimensional body using quadrilateral elements, and to provide a detailed derivation of the exact source panel integrations in order to gain insight for future research at Texas A&M University. A variation of the Hess method of surface discretization using quadrilateral source panels is described in detail as it is used in the XYZ Potential Flow program. The exact source panel integrations are derived in detail.

A general discussion of other aspects of the program is included. Velocities and pressure coefficients for flow about a triaxial ellipsoid are calculated using the XYZ Potential Flow Program solution, and the results are compared with the analytical solution and the Hess Program solution.

ACKNOWLEDGEMENTS

The author is thankful to Janet S. Dean of the David W. Taylor Naval Ship Research and Development Center, for her generous time on the telephone explaining details of the XYZ Potential Flow program which she co-authored, and to John L. Hess of McDonnell-Douglas Corporation, who, during a valuable phone conversation, suggested references which contained information necessary to complete the closed form source panel integrations. Appreciation is also expressed to Dr. Allen H. Magnuson, who provided direction as graduate committee chairman, and to Dr. David R. Basco and Dr. Leland A. Carlson who served as committee members.

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1.0 INTRODUCTION

This paper examines two aspects of the development of the XYZ Potential Flow Program (hereafter referred to as the XYZPF Program), a FORTRAN program which uses a source panel method to approximate solutions to steady potential flow problems about arbitrary three dimensional bodies. The aspects examined in detail are (1) the description of the details of the approximation of an arbitrary three-dimensional body using quadrilateral elements, and (2) a detailed derivation of the exact source panel integrations.

The XYZPF Program was developed specifically for applications in numerical ship modelling and hydrodynamics studies at the David W. Taylor Naval Ship Research and Development Center (NSRDC) in Bethesda, Maryland. The format of the program is based on the work of Hess and Smith (1962) in the numerical calculation of non-lifting potential flow. A similar program is maintained by the Aerodynamics Division of the McDonnell-Douglas Corporation, referred to in this paper as the "Hess program." The XYZPF Program is a modification of what has come to be known generally as the Hess Method. The most significant modifications are improvements to the method of solving the matrix equation for the source density, and greater flexibility in the input options (Dawson and Dean 1972).

Though potential flow is a product of mathematics, and is never found in a real fluid, the results of potential flow calculations provide usable information for flow regions external to a thin boundary layer,

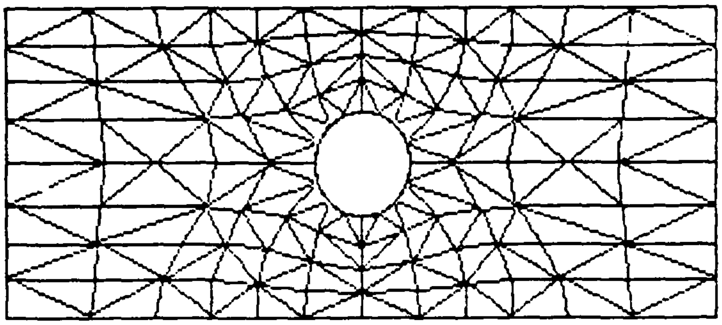
with little or no boundary layer separation. For such flow fields, the region outside the boundary layer may be considered to be effectively inviscid, and may be closely approximated by potential flow models. Small viscous effects can be accounted for by "thickening" the body by the appropriate displacement thickness. Displacement thickness accounts for the region of retarded fluid flow in the boundary layer inversely proportional to the square of the free stream velocity. Downstream of the point of boundary layer separation, the potential flow model no longer applies.

Prior to the development of numerical methods, analytical solutions were generally restricted to simple analytical shapes (Kellogg 1929). The need to solve boundary value problems for arbitrary boundaries in continuum mechanics has fostered the development of numerical approximations to the integral equation expressions. While the integration methods have been well known for quite some time, only since the advent of high speed computers have many of the problems been practical to solve by numerical methods. Among the numerical methods being used are finite differences, finite elements, and the boundary element method.

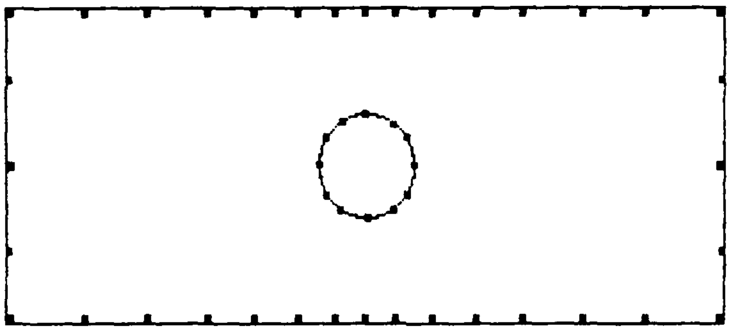
"Finite differences" and "finite elements" are numerical methods which satisfy the boundary conditions, and then approximate the solution to the governing equation in the fluid domain. These methods discretize the domain into a network of elements or cells.

Another approach is what is now known as the "Boundary Element Method," in which the governing equation is exactly satisfied in the domain, and the boundary conditions are applied through a boundary discretization method. The boundary value problem is reformulated as a boundary integral equation which is then discretized by subdividing the boundary into a finite number of surface elements. Each element is represented by an analytical function, and the source density function is integrated over the surface of each element. Two factors governing the accuracy of the boundary element method are the boundary discretization method and the source panel integration. These two factors are examined in detail in this report, as a detailed derivation of the exact source panel integration, including the development of the source panel geometry, has not previously appeared in literature.

The difference between the domain methods and the boundary methods is significant. The domain methods discretize the domain, while the boundary methods discretize the boundary. Thus, the boundary method reduces the dimension of the problem by one, as depicted in figure (1). In the application of the XYZPF Program, the problem is reduced from a three-dimensional problem in the domain to a two-dimensional problem on the boundaries. This method is well suited to problems in which the limits of the domain are infinite or difficult to define, in that the problem is applied to the boundary rather than the domain.



FINITE ELEMENT DISCRETIZATION



BOUNDARY ELEMENT DISCRETIZATION

Figure 1. Discretization Methods

Just as there are many variations of domain methods, there are also a variety of boundary methods. In general, they can be classified as "indirect" or "direct" formulations. The "indirect" method assumes a continuous source distribution over the surface of the body, and a solution which satisfies both the governing equation in the domain, and the boundary conditions on the body surface. The result is an integral equation on the boundary which has the surface source density function as its unknown. By enforcing the boundary conditions at control points on the surface, a system of equations is produced by which the source density may be determined.

The "direct" method solves the velocity potential function through

an application of Green's Second Identity requiring the solution of a source distribution and a dipole distribution on the boundary. The direct method has more physical significance to the general boundary value problem, and more versatility in its application as it can be applied to Neumann problems, Dirichlet problems, or mixed boundary value problems (Brebbia 1984).

The simplicity and accuracy of the indirect method has made it attractive for many applications. The source panel method is an application of the indirect formulation of the boundary element method to the Neumann type of potential flow problem, for which the normal derivative of the potential function is prescribed on the boundary.

1.1 OBJECTIVES

The purpose of this paper is (1) to describe the details of the approximation of an arbitrary three-dimensional body using quadrilateral elements, and (2) to provide a detailed derivation of the exact source panel integrations for use in future investigations at Texas A&M University using panels of higher order geometries and source density functions. This paper is not intended to be a user's manual, though a general discussion of other aspects of the program is also included. NSRDC Report 3892 (Dawson and Dean 1972) is a summary of the XYZPF Program for those strictly interested in its use.

2.0 HISTORICAL DEVELOPMENT

The foundations of the boundary element method were laid early in this century beginning with Fredholm in 1903 when he established the existence of solutions to the Neumann problem through a reconstruction of the problem using a discretized boundary (Kellogg 1929). The solution was determined to be the potential of a simple source distribution on a boundary with a continuous normal derivative for an infinite domain. Later works by Kellogg (1929) in potential theory demonstrated the application of the boundary integral equation method in electrostatics, heat transfer, flow in porous media, and fluid flow problems, but development was limited by the difficulty of obtaining analytical solutions. No significant advances were made until interest in boundary integral equation methods was revitalized with the advent of high speed electronic computers. Investigators were then able to discretize the boundaries and solve the integral equations numerically. This method of solution became known as the boundary element method. Early development of such numerical methods was pioneered by Hess and Smith (1962) and Jaswon and Symm (1963). Hess and Smith dealt primarily with the indirect formulation eventually leading to a solution for the three dimensional problem as described in this paper. In a parallel work, Jaswon and Symm developed a direct formulation approach to the two dimensional problem. The XYZPF Program is based primarily on the work of Hess and Smith. Hess has since developed a higher order panel method (Hess 1979) and Lefebvre modified the XYZPF Program for calculating velocity potentials for five degrees of freedom (Lefebvre 1982).

3.0 THEORETICAL DEVELOPMENT

3.1 THE POTENTIAL FLOW PROBLEM IN THREE DIMENSIONS

The governing equation for ideal (incompressible, inviscid, irrotational) flow is Laplace's equation:

$$\nabla^2 \Phi = 0 \tag{1}$$

where Φ is the velocity potential, and ∇^2 is the Laplacian operator. The XYZPF Program deals with steady, uniform flow of an ideal fluid about an arbitrary three dimensional body. The velocity components at any point within the flow field may be obtained from the negative gradient of the velocity potential, i. e.

$$\mathbf{V} = -\nabla\Phi = -\frac{\partial\Phi}{\partial x}\mathbf{i} - \frac{\partial\Phi}{\partial y}\mathbf{j} - \frac{\partial\Phi}{\partial z}\mathbf{k} \tag{2}$$

The freestream flow $\mathbf{V}_\infty$ is defined as a uniform stream of unit magnitude.

$$\left|\mathbf{V}_\infty\right| = \sqrt{V_{\infty x}^2 + V_{\infty y}^2 + V_{\infty z}^2} = 1 \tag{3}$$

The key to the boundary element method is the Divergence Theorem (Green's Theorem) which relates a volume integral to an equivalent surface integral reducing the three-dimensional problem to a

two-dimensional one. The expression for Green's second identity is (Lamb 1924):

$$\iiint (\Phi \nabla^2 w - w \nabla^2 \Phi)\, d\Omega = \iint \left(w \frac{\partial \Phi}{\partial n} - \Phi \frac{\partial w}{\partial n} \right) d\Gamma \qquad (4)$$

in which Ω represents the integration over the three dimensional domain, and Γ represents integration over the two dimensional boundary. The partial derivatives are taken with respect to the outward normal, n. The weighting function, w, is usually chosen to be the fundamental solution for three dimensions, $w = 1/(4\pi r)$, where r is the distance from the source to an arbitrary point on the boundary.

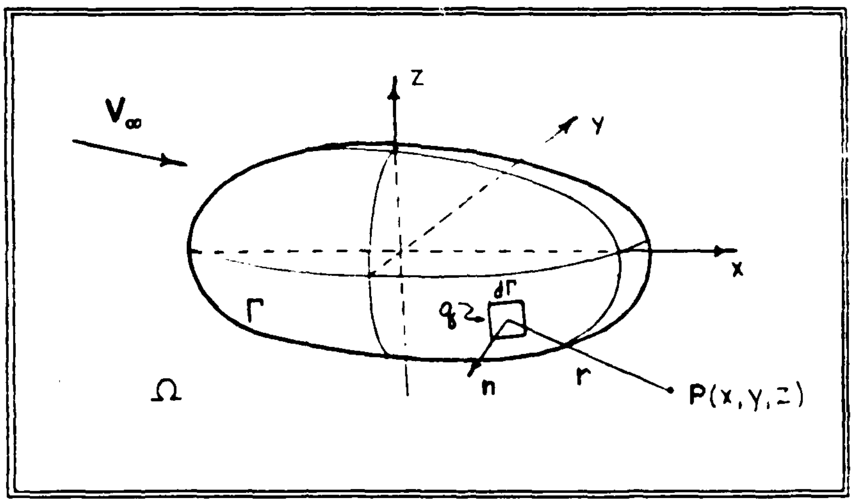


Figure 2. Potential Flow in Three Dimensions

Consider an arbitrary three-dimensional body with surface Γ, having an equation of the form $F(x, y, z) = 0$ where x, y, z are Cartesian coordinates of the global reference system as shown in Figure (2). The unit outward normal, **n**, at any point on the surface is given by the gradient of the function describing the surface divided by the magnitude

of the gradient, i.e.

$$\mathbf{n} = \frac{\pm\nabla F}{|\nabla F|} \tag{5}$$

where the sign of the unit normal vector is chosen to ensure that the vector is an outward normal. The potential function Φ describing the flow field must meet the following boundary conditions:

a. $\nabla^2\Phi = 0$ (Laplace's Equation) (6)

b. For an impermeable boundary, the velocity normal to the surface must be zero relative to the boundary (the Neumann boundary condition):

$$\left(\frac{\partial\Phi}{\partial n}\right)_\Gamma = 0 \tag{7}$$

c. The velocity potential approaches the freestream velocity potential as the distance from the body goes to infinity:

$$\Phi \rightarrow \Phi_\infty \quad \text{as} \quad |\mathbf{r}| \rightarrow \infty \tag{8}$$

The total potential at any point in the domain is composed of the freestream potential and the disturbance potential due to the body.

$$\Phi = \varphi_\infty + \varphi \tag{9}$$

The disturbance potential, φ, satisfies the following boundary conditions:

a. $\nabla^2\varphi = 0$ (10)

b. From equation (7), the velocity normal to the boundary due to the disturbance and due to the onset flow must be of equal magnitude, but opposite sign. Then from equation (9)

$$\left(\frac{\partial\varphi}{\partial n}\right)_\Gamma = \mathbf{n}(p) \cdot \mathbf{V}_\infty \tag{11}$$

Note that the normal vector is a function of position on the surface of the body.

c. The disturbance potential approaches zero as the distance from the body goes to infinity, i. e.

$$\varphi \rightarrow 0 \quad \text{as} \quad |\mathbf{r}| \rightarrow \infty \tag{12}$$

3.2 MATHEMATICAL MODEL

The disturbance potential of the body may be represented by a distribution of a source density function σ over the body surface. The potential at an arbitrary point P(x, y, z) due to the surface potential is (Kellogg 1929):

$$\varphi(x, y, z) = \iint \frac{\sigma(q)}{r(P,q)}\, d\Gamma \qquad (13)$$

wher q is the integration point on the surface, and

$$r(P,q) = \sqrt{(x - x_0)^2 + (y - y_0)^2 + (z - z_0)^2}$$

is the distance from the field point P to the integration point q.

The source density distribution function must satisfy the boundary conditions for the disturbance potential. Boundary conditions (10) and (12) are automatically satisfied by the form of the integrand. However, equation (11), the velocity normal to the boundary, combined with the Neumann boundary condition, equation (7), is the key to solving the boundary integral problem.

The integrand becomes singular as the surface of the body is approached, i. e. $|\mathbf{r}|$ goes to zero. The singularity represents the local fluid flux normal to the boundary due to the local source density. The principal value of the singularity is $-2\pi\sigma(p)$, determined through a limiting process of the Gauss Flux Theorem (Kellogg 1929). The point p represents a field point which lies on the boundary. The integral expression is now composed of the contribution of the local source density and the contribution of the source density function over the remainder of the body surface. Solving for the velocity normal to the surface yields the following expression:

$$\left(\frac{\partial\varphi}{\partial n}\right)_{\Gamma} = -2\pi\sigma(p) + \iint \frac{\partial}{\partial n}\left[\frac{\sigma(q)}{r(p,q)}\right] d\Gamma \qquad (14)$$

From equation (11), this expression becomes:

$$2\pi\sigma(p) - \iint \frac{\partial}{\partial n}\left[\frac{\sigma(q)}{r(p,q)}\right] d\Gamma = -\mathbf{n}(p) \cdot \mathbf{V}_{\infty} \qquad (15)$$

This equation is a two dimensional Fredholm integral equation of the second kind, which ensures a unique solution, and that the diagonal elements of the system matrix will be dominant, each having a value of 2π (Kellogg 1929). Once equation (15) has been solved for the source density σ, the velocity components at any point of the flow field may be obtained by differentiating the disturbance potential function (13) with respect to the coordinate directions and adding the components of the freestream flow, $\mathbf{V}_{\infty}$.

$$\mathbf{V}(x, y, z) = \mathbf{V}_{\infty} - \frac{\partial\varphi}{\partial x}\mathbf{i} - \frac{\partial\varphi}{\partial y}\mathbf{j} - \frac{\partial\varphi}{\partial z}\mathbf{k} \qquad (16)$$

The body shape does not have to be slender, axisymmetric, or simply connected, allowing for analysis of interior flow and a wide range of applications of the method. The only restriction imposed on the form of the body is that it must have a continuous normal vector. Discontinuities in the right hand side of equation (15) will produce unwanted singularities. Thus, in the process of approximating a body which has distinct corners, where there is clearly a discontinuity in the normal vector, the corner must be replaced by a surface with some finite

curvature. However, application of this method has shown that the flow calculations give correct results for convex corners, while unrounded concave corners may or may not produce significant error, depending on the angle produced by the corner (Hess and Smith 1962).

Because of the method of approximation, the calculation of flow velocities on the body surface are restricted to the points at which the boundary conditions were applied. Velocities at points other than those must be obtained by interpolation. Direct calculation of velocities at the edge of an element yields infinite velocities.

With the solution of the system of linear equations for the source densities, the flow velocities at any point in the domain may be obtained from equation (16), and pressure coefficients are then computed from the velocities using a form of the Bernoulli equation:

$$P(t) = \frac{p}{\rho} + \frac{1}{2}\left|\mathbf{V}\right|^2 + \frac{\partial \Phi}{\partial t} \qquad (17)$$

where P(t) is a constant independent of position. In the XYZPF Program, the flow is steady. Therefore, equation (17) can be reduced to

$$p + \frac{1}{2}\rho\left|\mathbf{V}\right|^2 = \text{constant} \qquad (18)$$

and the pressure field can be expressed in terms of a dimensionless pressure coefficient C_p as:

$$C_p = \frac{p - p_\infty}{\frac{1}{2}\rho\left|\mathbf{V}_\infty\right|^2} = 1 - \frac{\left|\mathbf{V}\right|^2}{\left|\mathbf{V}_\infty\right|^2} \qquad (19)$$

where p_∞ is the static pressure at infinity.

3.3 NUMERICAL MODEL

In order to represent the surface of a body in the domain mathematically, the body may be described by analytical expressions which may provide an exact representation of the surface. However, the types of bodies which can be adequately described by such methods are severely limited. Another way to represent the body is to use a large number of analytical expressions, each describing only a small portion of the body. Hess and Smith (1962) suggested the use of an assembly of flat quadrilateral elements to model the actual surface of the body, as shown in Figure (3). Each quadrilateral approximates a region of the surface described by points which lie on the actual surface of the body. As planar elements, these quadrilaterals are clearly analytical, and when carefully constructed, the elements can approximate arbitrary three dimensional body surfaces without restriction.

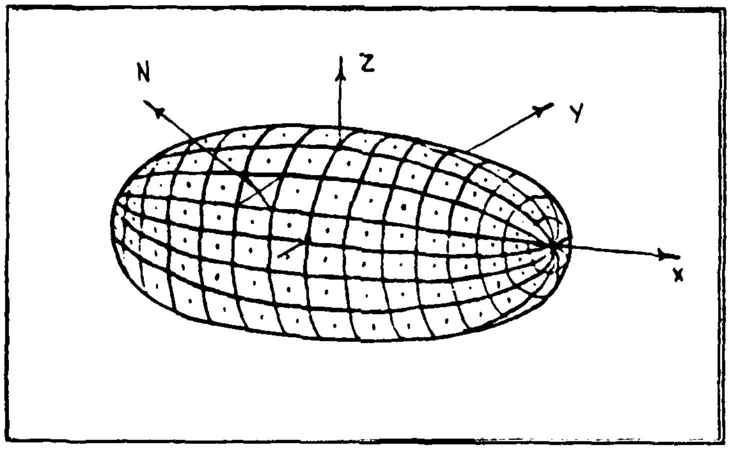


Figure 3. Approximation of the body by surface elements

The XYZPF Program uses the discretization procedure described by Hess and Smith (1962) with some minor modifications. The three dimensional body surface may be described using a large number of plane quadrilateral elements, each assumed to have a constant source density over the area of each element. Regions of the body requiring higher resolution for sharp curvature or anticipated velocity gradients will require a higher concentration of elements.

Because the plane quadrilateral elements cannot fit edge to edge on a rounded surface, small gaps in the panel approximation contribute to the error of the approximation. However, the error due to the gaps is negligible when compared with the error of the basic model, that is, using flat panels to approximate a curved surface. Triangular elements have been suggested in an attempt to eliminate the gaps (Levy 1959), but the increased accuracy is so small that it may not justify the additional work of organizing the triangular elements in lieu of the simpler quadrilaterals (Hess and Smith 1966). The method presented is valid for an polygonal element with any number of sides.

Equation (15) can now be decomposed into a summation of integrals, each representing the contribution of one element of the body surface. The unknown source density can be taken outside the integral, since it is assumed to be a constant over each element. The integration is performed over the area of the source element, and the boundary condition equation (11) is then enforced at a single point p in each remaining element. By performing this operation at each element of the

surface, a system of linear equations is generated which is equal in number to the number of surface elements and the number of unknown source densities. Equation (15) can now be approximated by the matrix equation (Dawson and Dean 1972):

$$\sigma_i = \sum_j \sigma_j C_{ij} + V_i \qquad (20)$$

where

$$C_{ij} = \frac{1}{2\pi} \iint_j \frac{\partial}{\partial n_i} \left[\frac{1}{r_{ij}} \right] dA$$

$$C_{ii} = 0$$

$$V_i = -\frac{1}{2\pi} \left[\mathbf{n}_i \cdot \mathbf{V}_\infty \right]$$

It is important to note that the influence coefficients C_{ij} and C_{ii} are functions of geometry only, and once computed, need not be recomputed for analysis of several different flows. From the solution of equation (20) on the discretized surface, equation (13) may be applied at any point in the domain. Then, the velocity at an arbitrary field point P(x, y, z) in the domain may be determined from equation (16). With the velocity known, the pressure coefficient is determined from equation (19).

4.0 ORGANIZATION OF THE PROGRAM

The XYZPF Program is actually composed of seven independent programs, referred to as sections PF1 through PF7, each of which builds on data generated from a previous section. This type of organization allows the user the flexibility of rerunning portions of the program using different flow parameters without having to go through the time consuming process of recalculating the influence coefficient matrix, which is dependent only on the geometry of the body. While the NSRDC program is very similar to the Hess program, there are also some significant differences. The following list of differences is taken from NSRDC Report 3892 (Dawson and Dean 1972):

(1) The input to XYZ PF is arranged to facilitate the preparation of input for a series of problems in which only one part of the body is changed. Also, a number of checks are made on the input to help detect errors.

(2) An option was added for the recomputation of the source density and velocities for only part of the body when only small changes are made. This option also provides for the use of the solution of one problem as an initial guess for the solution of another problem.

(3) The matrix of influence coefficients is computed column by column instead of row by row. This column arrangement was used for the original LARC computer version because it required much less high speed memory. The computation is also about 10% faster this way than with the row-by-row arrangement.

(4) A simultaneous displacement iterative scheme is used to solve

the matrix coefficient for the source density. The scheme is slower than the successive displacement (Gauss-Seidel) scheme used in the Hess program, but it can be carried out using the matrix column by column instead of row by row.

(5) When possible, an extrapolation procedure is used to reduce the number of iterations required for convergence. One such method is the Richardson extrapolation.

The methods used in the XYZPF Program will be discussed in detail in the following sections.

5.0 DETAILS OF THE SURFACE APPROXIMATION

5.1 PREPARATION OF THE INPUT

Section PF1 is set up to read and store the input data, and to examine the cornerpoints of the quadrilaterals to detect obvious errors in the input. Because of the number of points which may have to be entered for a complex geometry, the user input is a major source of program error, and this first look for input errors will save lot of run time in the program as a whole. If Section PF1 detects major errors in the input, the program will not continue with the calculation of the coefficient matrix, but will stop and identify the grid location of the error. Minor errors may not cause the program to stop, but will be noted in the output.

One of the major advantages to this program is in the organization of the input data. The surface is input in sections so that small portions of the input geometry may be changed without having to recalculated the points for the entire surface. The program also takes advantage of symmetry to minimize the input effort. Only the portion of the body which has no redundancy needs to be entered point by point. The remainder of the body is reflected across the planes of symmetry by the program to complete the surface representation.

The surface is represented by a set of points in three-dimensional space which lie on the actual surface, and which will later be used to define the plane quadrilateral source elements. These points are defined in the global reference system. The points on the surface should be

selected in such a way as to provide an accurate representation of the surface with the fewest number of points possible. Portions of the surface which are highly curved will require a larger number of points to provide adequate resolution. Additionally, portions of the surface in which the flow field is expected to change rapidly will require a large number of points to accurately determine the flow field in that region. Some familiarity with fluid dynamics will provide a somewhat intuitive approach to properly distributing the elements. Elements should change gradually in size from areas of high concentration to those of just a few large elements, changing no more than 50 percent in size between adjacent elements (Hess and Smith 1966). The accuracy is only as good as that provided by the largest element in a particular area. The use of quadrilateral elements facilitates the use of known analytical equations and body contours to determine the input points.

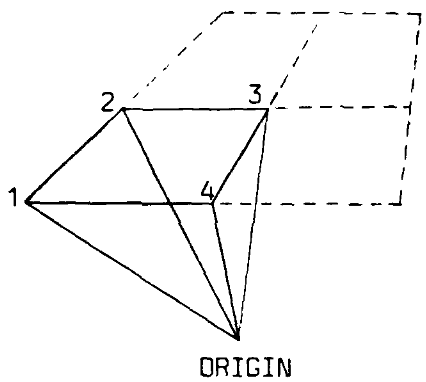


Figure 4. The 3D quadrilateral element in global coordinates

For the purposes of this program, the body surface is represented by a large number of plane quadrilateral elements as shown in figure (3), each of which is assumed to have a constant value of source density over the area of the element. Each element is defined by four input points

which lie on the actual surface as shown in figure (4). Since each input point can be used as a corner for up to four elements, there is no need to enter the same point four separate times. The input points are organized in groups of four to form the quadrilateral element, and each point may also be associated with adjacent quadrilaterals. This is accomplished through the use of a two dimensional coordinate system in which the user assigns a pair of integers, m and n, to each point which identifies the "row" and the "column" in which it lies. A column of points will be given a common value of n, and each point in that column will have a unique value of m corresponding to the row in which the point lies. The orientation of these "coordinate" integers determines the direction of the outward normal for each element. Looking from the flow field toward the section of elements, if the values of m are increasing upward, the values of n must increase to the right. Increasing m and n can point in any direction with respect to the global reference system. In fact, the orientation can change from one section to another. However, any other relationship between m and n will produce an incorrect normal vector. Once assigned, the values of m and n also serve to identify the element for which the corresponding point is a corner. The four points which form a quadrilateral element are two points of one column, or n line, with consecutive m numbers, and two points of the next higher n line with the same m numbers as the previous two points. Thus, the element m, n is composed of the points identified by (m, n), (m+1, n), (m, n+1), and (m+1, n+1).

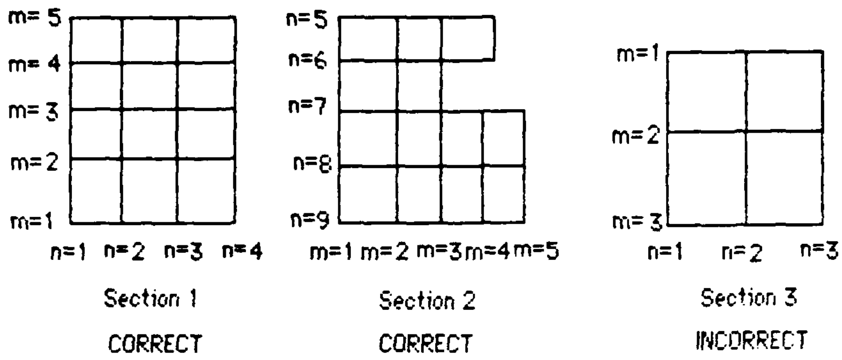


Figure 5. Quadrilateral index numbers

Each section of the body surface is formed by specifying a set of corner points corresponding to the m, n pairs for all of the quadrilaterals of the section. The user will sequentially assign an m number to the points for each n line, and also number the n lines for the section points entered. The first point in each n line will always have m = 1. The n lines are also numbered sequentially, but the value of n is not reset for each new section. The sequence of n numbers runs through all the sections as shown in figure (5). Points on a particular row or column do not have to be strictly colinear. By forming nearly triangular elements, a rounded planform can be approximated without conflicting with the numbering convention, as shown in figure (6).

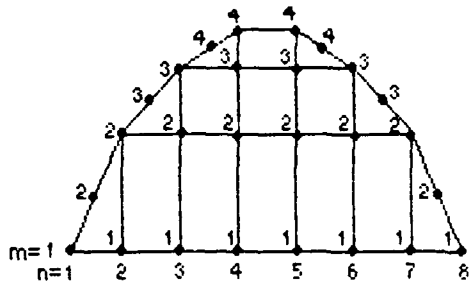


Figure 6. Approximating a thin region with rounded planform (Hess & Smith 1962)

By entering data in sections, small changes in geometry can be performed without having to reenter all the points associated with the body surface. This feature is unique to the XYZPF Program, and offers a great deal of flexibility in design work. However, with the added flexibility comes more restrictions on both the input of the original geometry and on any modifications. There are four important restrictions on the input which are required to provide quadrilateral elements in groups of four to facilitate geometry calculations (Dawson and Dean 1972):

(1) There must be an even number of elements in both the m and n directions in each section of the body.

(2) The common corner point of a group of four elements must not coincide with any other corner point. The sides between the elements serve to define the local coordinate system, and serve as the axis of rotation when the surface is flattened for numerical differentiation of

the velocity potential.

(3) Each set of four elements must have at least seven distinct corner points to allow the elements to more closely conform to a curved surface. This also allows for convergence of N-lines or M-lines as may occur, for example, at the leading edge of an ellipsoid. Thus, only two of the four quadrilateral may degenerate into triangles by having two of their corner points coincide. This does not necessarily eliminate the possibility of more than two "triangular" elements since the adjacent sides of a quadrilateral may be colinear as shown in figure (6).

(4) The normal vectors between two adjacent quadrilaterals in a group of four must be less than 90 degrees and preferably less than 45 degrees. If a sharp edge is required, it should be a concave corner with respect to the flow field, and the input should be arranged so that the edge is along an outside boundary of the groups of four, and not through the center.

When making small changes to the original geometry, the number of elements used in a new section must be the same as the number used in the original section unless the part being changed is at the end of the input data. Section configurations may be selected by natural divisions, as a matter of convenience to more easily handle large numbers of points, or as a tool to take advantage of symmetry.

In setting up input data to use planes of symmetry, it is important to note that the XYZPF Program has certain restrictions on the choice of

symmetry planes. The user only has the option to select the number of symmetry planes. The planes which will be used as symmetry planes are preselected by the program to optimize the calculation procedure. Therefore, knowing this, the preparation of input data must consider the following restrictions imposed by the program (Dean and Dawson 1972).

If only one plane of symmetry is used, the plane of symmetry is the $y = 0$ plane of the global coordinate system. As such, all the y coordinates of the input points must be of the same sign, i. e., all positive or all negative. If the body is closed and intersects the plane of symmetry, the points touching the plane, i. e., corresponding to $y = 0$, must also be entered with the input points.

If two planes of symmetry are used, the planes of symmetry are the $y = 0$ plane and the $z = 0$ plane in the global coordinate system. Again, the y coordinates of all input points must have the same sign, positive or negative, and the z coordinates of all points must be of the same sign, positive or negative without regard to the sign of y. If the body surface intersects one or both of the planes of symmetry, the points which lie in the plane, i. e., those corresponding to $y = 0$ or $z = 0$, must also be entered with the input points.

If three planes of symmetry are used, clearly the planes are the reference planes of the global coordinate system. As with the previous cases, all the x coordinates of the input points must be of the same sign, and similarly for the y and z coordinates. If any part of the body intersects any of the planes of symmetry, the points which lie in that

plane, i. e., $x = 0$, $y = 0$ or $z = 0$, must also be entered with the input points.

5.2 SOURCE PANEL GEOMETRY

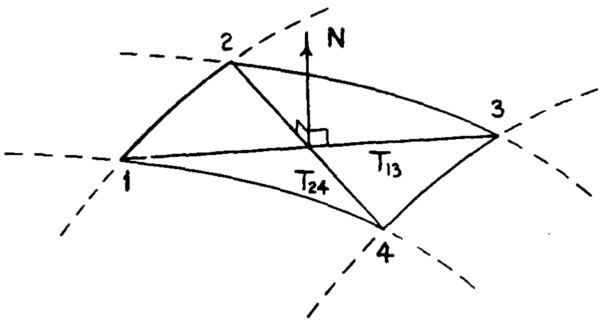


Figure 7. The outer normal to the quadrilateral element

With the surface points identified by the location numbers, m and n, and arranged in accordancewith program requirements, calculation of various aspects of the source panel geometry and formation of the plane quadrilateral element is the next step in the numerical integration process. Formation of all of the planar elements is identical, so the following discussion of source panel geometry will deal with only one characteristic element. The four corner points forming the basic quadrilateral are numbered in a clockwise direction from 1 to 4 as shown in figure (7). It does not matter which corner point is identified with the number 1 subscript, but the remaining points must be numbered consecutively in a clockwise direction when observed from the flow field in order to ensure an outward directed normal vector. These subscripts will be used to identify the corner points for the remainder of this discussion. For this example, the points will be identified as follows:

Position Numbers	Global Coordinates
m, n	X_1, Y_1, Z_1
m+1, n	X_2, Y_2, Z_2
m+1, n+1	X_3, Y_3, Z_3
m, n+1	X_4, Y_4, Z_4

In forming the plane quadrilateral elements, the corner points, which are generally not coplanar, are used to form the local coordinate system, relative to the element. Recalling that the cross product of two vectors yields a vector solution which is perpendicular to both of the original vectors, the normal to the element may be obtained from the cross product of the diagonals of the element,

$$\mathbf{N} = \mathbf{T}_{24} \times \mathbf{T}_{13} \tag{21}$$

where $\mathbf{T}_{13}$ is the vector from point 1 to point 3, and $\mathbf{T}_{24}$ is the vector from corner point 2 to point 4. The unit normal is then:

$$\mathbf{n} = \frac{\mathrm{T}_{24} \times \mathrm{T}_{13}}{\left| \mathrm{T}_{24} \times \mathrm{T}_{13} \right|} \tag{22}$$

This unit normal now represents the first of the three local coordinate directions, this one in the ζ direction. The side of the quadrilateral from point 2 to point 3 is then used to obtain the second coordinate vector.

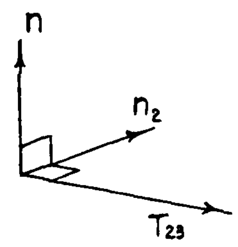


Figure 8. The second local coordinate vector

$$N_2 = n \times T_{23} \tag{23}$$

and the unit vector

$$n_2 = \frac{N_2}{|N_2|} \tag{24}$$

Similarly, the third local coordinate vector is obtained from the crossproduct of $\mathbf{n}_2$ and $\mathbf{n}$, the result of which is a unit vector.

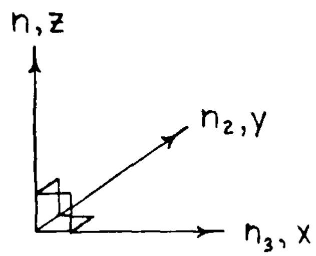


Figure 9. The third local coordinate vector

$$n_3 = n_2 \times n \tag{25}$$

The unit vectors $\mathbf{n}_3$, $\mathbf{n}_2$, and $\mathbf{n}$ form an orthonormal basis and define the local coordinate system for the element in the ξ, η, and ζ directions

respectively. Other methods of obtaining an orthonormal basis could be used just as well, and would make no difference to the remaining computations. The origin of the local coordinate system would most correctly be located at the "null point," the point at which the velocity potential has no contribution to the tangential velocity component on the source element. The null point is the point in each quadrilateral element where the normal velocity boundary condition is applied. However, with the exception of long, thin quadrilaterals, the physical difference between the null point and the centroid of the quadrilateral is not significant. The XYZPF Program will print a warning in the output when a quadrilateral is long and thin enough to jeopardize the accuracy of the approximation in that region. By locating the origin of the local coordinate system at the centroid, rather than at the null point, the difficult process of locating the null point for each element can be eliminated, later calculations of the multipole expansion can be simplified, and the boundary conditions can be applied at the centroid without contributing significant error to the approximation (Hess and Smith 1966). Therefore, the origin for each local coordinate system is located at the centroid for the respective element.

5.3 LOCATING THE CENTROID

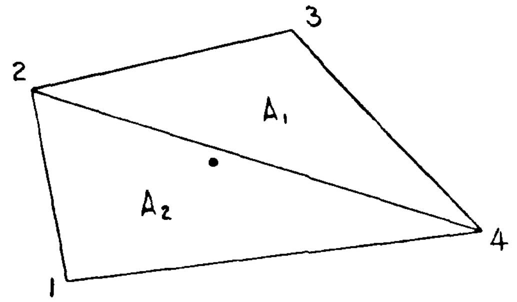


Figure 10. Locating the centroid of the quadrilateral

The centroid of the element may be calculated by first dividing the area of the quadrilateral into two triangular areas, the triangles being separated by the line from point 2 to point 4. The area A_1 of the triangle defined by corner points 2, 3, and 4 is

$$A_1 = \frac{1}{2} \left| T_{24} \times T_{23} \right| \tag{26}$$

Similarly, the area A_2 of the triangle defined by corner points 1, 2, and 4 is

$$A_2 = \frac{1}{2} \left| T_{12} \times T_{14} \right| \tag{27}$$

In the global coordinate system, the X component of the centroid is given by

$$\overline{X} = \frac{A_1 \overline{X}_1 + A_2 \overline{X}_2}{A_1 + A_2} \tag{28}$$

where X_1 and X_2 are the averages of the X components of the corner points of each triangle. Substituting the values for X_1 and X_2:

$$\overline{X} = \frac{\frac{1}{3}A_1(X_2+X_3+X_4) + \frac{1}{3}A_2(X_1+X_2+X_4)}{A_1 + A_2}$$

$$= \frac{1}{3}\left[\frac{(A_1+A_2)X_2 + (A_1+A_2)X_4 + A_1X_3 + A_2X_1}{A_1 + A_2}\right]$$

$$= \frac{1}{3}\left[X_2 + X_4 + \frac{A_1X_3 + A_2X_1}{A_1 + A_2}\right] \quad (29)$$

Similarly

$$\overline{Y} = \frac{1}{3}\left[Y_2 + Y_4 + \frac{A_1Y_3 + A_2Y_1}{A_1 + A_2}\right] \quad (30)$$

$$\overline{Z} = \frac{1}{3}\left[Z_2 + Z_4 + \frac{A_1Z_3 + A_2Z_1}{A_1 + A_2}\right] \quad (31)$$

5.4 COORDINATE TRANSFORMATION

Now that the local coordinate system is formed and properly located at the centroid of the element, the global coordinates of the corner points (X, Y, Z) are transformed to local coordinates (ξ, η, ζ) through the components of the reference vectors of the local coordinate system as follows:

$$\begin{bmatrix} n_{3_x} & n_{3_y} & n_{3_z} \\ n_{2_x} & n_{2_y} & n_{2_z} \\ n_x & n_y & n_z \end{bmatrix} \begin{bmatrix} X - \overline{X} \\ Y - \overline{Y} \\ Z - \overline{Z} \end{bmatrix} = \begin{bmatrix} \xi \\ \eta \\ \zeta \end{bmatrix} \quad (32)$$

The corner points are projected into the plane of the quadrilateral element by setting the ζ components to zero. The original diagonal vectors, T_{13} and T_{24}, will be on opposite sides of the resulting plane. The plane quadrilateral element is now completely defined. The program will sweep through all of the input elements using the assigned location numbers, and repeat this process for each element.

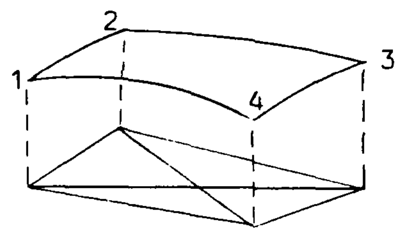


Figure 11. Forming the plane quadrilateral element

5.5 MOMENTS OF INERTIA

The calculation of the moments of inertia for each element are performed for use in the computation of the velocity coefficients using the quadrupole method. Any calculus text will give the moments of inertia of a planar section with a constant unit density about the origin to be:

$$I_{xx} = \iint_A \xi^2 \, d\xi \, d\eta \tag{33}$$

$$I_{yy} = \iint_A \eta^2 \, d\xi \, d\eta \tag{34}$$

$$I_{xy} = \iint_A \xi \, \eta \, d\xi \, d\eta \tag{35}$$

For the triangular region defined by the corner points 2, 3, and 4,

$$I_{xx} = \frac{A}{12}\left[(\xi_2 + \xi_3)^2 + (\xi_3 + \xi_4)^2 + (\xi_4 + \xi_2)^2 \right] \tag{36}$$

$$I_{yy} = \frac{A}{12}\left[(\eta_2 + \eta_3)^2 + (\eta_3 + \eta_4)^2 + (\eta_4 + \eta_2)^2 \right] \tag{37}$$

$$I_{xy} = \frac{A}{12}\left[(\xi_2 + \xi_3)(\eta_2 + \eta_3) + (\xi_3 + \xi_4)(\eta_3 + \eta_4) + (\xi_4 + \xi_2)(\eta_4 + \eta_2) \right] \tag{38}$$

Similar equations can be generated for the triangular region defined by the corner points 1, 2, and 4. The moment of inertia for the entire quadrilateral is the sum of the corresponding expressions for each of the triangles. The resulting equations are:

$$I_{xx} = \frac{A}{12}\left[(\xi_2 + \xi_3)^2 + (\xi_3 + \xi_4)^2 + (\xi_4 + \xi_2)^2 \right] + \frac{A}{12}\left[(\xi_1 + \xi_2)^2 + (\xi_2 + \xi_4)^2 + (\xi_4 + \xi_1)^2 \right] \tag{39}$$

$$I_{yy} = \frac{A}{12}\left[(\eta_2 + \eta_3)^2 + (\eta_3 + \eta_4)^2 + (\eta_4 + \eta_2)^2 \right] + \frac{A}{12}\left[(\eta_1 + \eta_2)^2 + (\eta_2 + \eta_4)^2 + (\eta_4 + \eta_1)^2 \right] \tag{40}$$

$$\begin{aligned} I_{xy} = {} & \frac{A}{12}\left[(\xi_2 + \xi_3)(\eta_2 + \eta_3) + (\xi_3 + \xi_4)(\eta_3 + \eta_4) + (\xi_4 + \xi_2)(\eta_4 + \eta_2) \right] \\ & + \frac{A}{12}\left[(\xi_1 + \xi_2)(\eta_1 + \eta_2) + (\xi_2 + \xi_4)(\eta_2 + \eta_4) + (\xi_4 + \xi_1)(\eta_4 + \eta_1) \right] \end{aligned} \tag{41}$$

6.0 THE MATRIX OF INFLUENCE COEFFICIENTS

With the quadrilaterals completely formed, the next step is to calculate the velocities induced by the elements at the centroids of all the other elements. The total number of elements forming the surface will be represented by N. Let the source element be the (j)th element, and the element for which the velocity components are to be calculated at the centroid is the (i)th element. It does not matter how the (i)th elements are arranged in relation to each other as the sequence progresses. However, the sequence must be consistent as the calculations proceed from one source element to another. This program sweeps through the (i)th elements in the order of their location numbers, m and n. For each consecutive n line, the elements are swept in order of increasing m numbers.

The result of the induced velocity calculations for the elements with unit source densities is an N by N square matrix of the values of induced velocities at each element, known also as the "matrix of influence coefficients." The XYZ potential flow program calculates the coefficients column by column, while the Hess program calculates them row by row. The advantage of one over the other depends on the method of later solving the matrix for the source densities. In calculating the influence coefficients, twenty-five quantities which describe the geometry of the source element are required to adequately calculate the induced velocity at the centroid of the (i)th element. These quantities include the coordinates of the centroid in the global coordinate system, the elements of the coordinate transformation matrix, the local

coordinates of the corner points, the maximum diagonal, the area, and the second moments of the quadrilateral element. Additionally, the Hess program uses the coordinates of the null point, making a total of twenty-eight quantities for that method (Hess and Smith 1962).

When calculating row by row, the first (i)th element is selected, containing the "null" point, and the influence coefficients are computed for all of the (j)th elements in sequence before proceeding to the (i+1)th element. This procedure requires the twenty-five quantities for each (j)th element to be available for calculation of the influence coefficient. Because each of the N (j)th elements is used N times with this procedure, calculating the geometric quantities or retrieving the values from low speed memory would be very time consuming, since the calculations or memory access would need to be performed N^2 times. Therefore, it is more practical to have the values available in high speed memory, although large matrices may exceed the storage capacity of high speed memory, imposing a limit on the number of elements which can be used. The advantage to the row-by-row calculation is that solution of the resulting matrix by the Gauss-Seidel reduction method does not require transposing the matrix, which would be another time consuming process (Hess and Smith 1962).

Another alternative is calculation of the influence coefficients column by column. This method calculates the influence coefficients by sweeping all the (i)th elements for each (j)th element before proceeding to the (j+1)th element. Therefore, the twenty-five geometric quantities are retrieved from low speed storage only once for each (j)th element,

for a total of N times. This procedure is not limited by the capacity of high speed memory, and calculation of the coefficient matrix is approximately 10% faster than the row-by-row method (Dawson and Dean 1972). This is the calculation method used by the XYZ Potential Flow Program.

An influence coefficient represents the combined effects on one element of the velocity potentials of all the other elements comprising the body surface. For the quadrilateral element with a unit source density in the xy-plane, from equation (13), the potential at point P (x, y, z) due to the element is

$$\psi = \oint\!\!\oint_A \frac{1}{r}\, dA = \oint\!\!\oint_A \frac{d\xi\, d\eta}{\sqrt{(x-\xi)^2 + (y-\eta)^2 + z^2}} \qquad (42)$$

The integrand, $1/r$, can be expanded in a series about the origin in powers of ξ and η. Each term of the series will contain the product of some powers of ξ and η with a corresponding derivative of $1/r_0$, where r_0 is the distance of the field point P from the quadrilateral origin.

$$r_0 = \sqrt{x^2 + y^2 + z^2}$$

and let

$$W = \frac{1}{r_0}$$

Then the series expansion through the second order term is (Hess and Smith 1962):

$$\varphi = Aw - (M_x w_x + M_y w_y) + 1/2(I_{xx} w_{xx} + 2 I_{xy} w_{xy} + I_{yy} w_{yy}) + \ldots \quad (43)$$

The subscripts, x and y, used with w represent the respective partial derivatives. This series represents the multipole expansion of the velocity potential, since each term can be interpreted as a point singularity of a particular order. The first term is the potential at point P due to a point source of strength A located at the origin. The second term is the sum of two dipoles of strengths M_x and M_y located at the origin, oriented along the x and y axis respectively. The choice of the centroid of the quadrilateral as the origin of the local coordinate system causes the first moments, M_x and M_y, to be zero. Therefore, the dipole terms dissappear, and are not dealt with anywhere in the program. The third term is the sum of three quadrupoles of strengths I_{xx}, I_{xy}, and I_{yy} located at the origin. Kellogg (1929) shows that this second order approximation is absolutely and uniformly convergent, and Hess and Smith (1962) show that convergenceis rapid enough with an increase in r_0 that certain further approximations may be made without significant error at large distances r_0 from the source quadrilateral.

Hess and Smith (1962) presented a comparison of velocities calculated using the exact formulas, a simple point source, and a second order approximation. The comparisons were based on the ratio of the distance r_0, between the centroid of the source quadrilateral and the field point P, to the length of the maximum dimension t, of the source quadrilateral, typically the maximum diagonal. The non-dimensional ratio is then r_0/t. The results show that sufficient accuracy is maintained

while using a simple point source at ratios of $(r_0/t) \geq 4$, using the second order source and quadrupole solution for the range $2.45 \leq (r_0/t) < 4$, and using the exact solution for ratios of $(r_0/t) < 2.45$. In any case, the error goes to infinity as the field point approaches the edge of the quadrilateral where calculations indicate an infinite velocity. The XYZ Potential Flow Program uses a monopole source for $(r_0/t) > 4$, the source - quadrupole formulae for $2 < (r_0/t) \leq 4$, and the exact formulae for $(r_0/t) \leq 2$. Hess and Smith (1962) reported a maximum error of 0.001 in approximating any velocity component using the above criteria.

7.0 DERIVATION OF THE EXACT SOURCE PANEL INTEGRATION

From equations (2) and (42), the components of the velocity at the field point P(x, y, z) due to the source quadrilateral are:

$$V_x = -\frac{\partial \varphi}{\partial x} = \iint_A \frac{(x-\xi)\, d\xi\, d\eta}{r^3} \qquad (44)$$

$$V_y = -\frac{\partial \varphi}{\partial y} = \iint_A \frac{(y-\eta)\, d\xi\, d\eta}{r^3} \qquad (45)$$

$$V_z = -\frac{\partial \varphi}{\partial z} = \iint_A \frac{z\, d\xi\, d\eta}{r^3} \qquad (46)$$

Equations (44), (45) and (46) are evaluated by expressing each of the integrals as the sum of four terms, each term representing the effect of one side of the quadrilateral (Hess and Smith 1962). This method can also be generalized for polygonal elements with any number of sides. The potential function for each side of the quadrilateral is the combined potentials of semi-infinite strips whose boundaries are the side of the quadrilateral and two semi-infinite lines parallel to either the x or y axis. When observed from the domain, and the sides are traversed in a clockwise direction, the source strip on the right will have a source density of $\sigma = +1/2$ and the source strip on the left will have a source density of $\sigma = -1/2$ as shown in figure (12). When the sides are recombined to form the quadrilateral, the source densities outside the quadrilateral cancel each other, and the source densities within the quadrilateral combine to form a source density of $\sigma = +1$. This will be

true for a planar element with any number of sides and in any relative orientation within the plane.

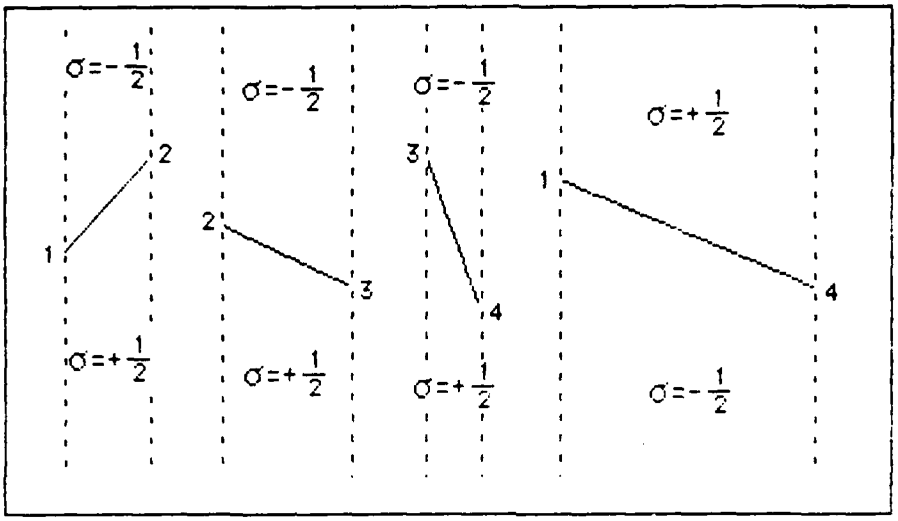


Figure 12. Fundamental potential functions for sides of a quadrilateral (Hess & Smith 1962)

7.1 THE Y VELOCITY COMPONENT

From equation (45), the velocity component V_y is found by summing the four terms representing the contributions of the sides of the quadrilateral. For the side from point (ξ_1, η_1) to point (ξ_2, η_2), the contribution is expressed as the integral over the area of the semi-infinite strips with the source densities of $\sigma = +1/2$ and $\sigma = -1/2$ rather than the unit source density of equation (45).

$$V_{y_{12}} = \int_{\xi_1}^{\xi_2} d\xi \left[\frac{1}{2} \int_{-\infty}^{\eta_{12}} - \frac{1}{2} \int_{\eta_{12}}^{\infty} \right] \frac{(y-\eta)\,d\eta}{r^3} \tag{47}$$

$$V_{y_{12}} = \frac{1}{2} \int_{\xi_1}^{\xi_2} d\xi \left[\int_{-\infty}^{\eta_{12}} - \int_{\eta_{12}}^{\infty} \right] \frac{(y-\eta)\,d\eta}{[(x-\xi)^2 + (y-\eta)^2 + z^2]^{3/2}}$$

Integrating with respect to η:

$$V_{y_{12}} = \frac{1}{2}\int_{\xi_1}^{\xi_2} d\xi \left\{ \frac{1}{[(x-\xi)^2+(y-\eta)^2+z^2]^{1/2}}\Bigg|_{\eta_{12}} \right.$$

$$- \frac{1}{[(x-\xi)^2+(y-\eta)^2+z^2]^{1/2}}\Bigg|_{-\infty} - \frac{1}{[(x-\xi)^2+(y-\eta)^2+z^2]^{1/2}}\Bigg|_{\infty}$$

$$\left. + \frac{1}{[(x-\xi)^2+(y-\eta)^2+z^2]^{1/2}}\Bigg|_{\eta_{12}} \right\}$$

The terms evaluated at $\eta = +\infty$ and $\eta = -\infty$ cancel, and the terms evaluated at $\eta = \eta_{12}$ add to obtain the following expression:

$$V_{y_{12}} = \frac{1}{2}\int_{\xi_1}^{\xi_2} \frac{2\,d\xi}{[(x-\xi)^2+(y-\eta)^2+z^2]^{1/2}}$$

$$V_{y_{12}} = \int_{\xi_1}^{\xi_2} \frac{d\xi}{r} \tag{48}$$

Equation (48) is changed to a function of arclength s by the relation

$$\frac{d\xi}{ds} = \frac{\xi_2 - \xi_1}{\sqrt{(\xi_2-\xi_1)^2+(\eta_2-\eta_1)^2}} = \frac{\xi_2 - \xi_1}{d_{12}} \tag{49}$$

where d_{12} is the length of the side of the quadrilateral from (ξ_1, η_1) to (ξ_2, η_2) as shown in figure (13).

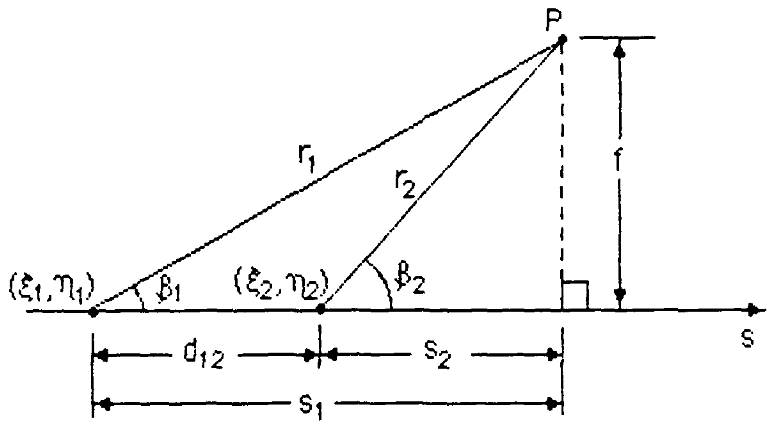


Figure 13. The potential due to a finite line source (Hess & Smith 1962)

Substituting equation (49) into equation (48)

$$V_{y_{12}} = \frac{\xi_2 - \xi_1}{d_{12}} \int_0^{d_{12}} \frac{ds}{r} \qquad (50)$$

From figure (13), it can be seen that, in terms of arclength s, the distance r from point P to any point on the line from point 1 to point 2 is given by

$$r = \sqrt{f^2 + (s_1 - s)^2}$$

Substituting into equation (50) yields

$$V_{y_{12}} = \frac{\xi_2 - \xi_1}{d_{12}} \int_0^{d_{12}} \frac{ds}{\sqrt{f^2 + (s_1 - s)^2}}$$

$$= \frac{\xi_2 - \xi_1}{d_{12}} \int_0^{d_{12}} \frac{ds}{\sqrt{f^2 + (s - s_1)^2}} \qquad (51)$$

Evaluating the integral

$$V_{y_{12}} = \frac{\xi_2 - \xi_1}{d_{12}} \log\left[(s - s_1) + \sqrt{f^2 + (s - s_1)^2}\,\right]\Bigg|_0^{d_{12}}$$

$$= \frac{\xi_2 - \xi_1}{d_{12}} \left\{ \log\left[(d_{12} - s_1) + \sqrt{f^2 + (d_{12} - s_1)^2}\,\right] - \log\left[(-s_1) + \sqrt{f^2 + (-s_1)^2}\,\right] \right\}$$

$$= \frac{\xi_2 - \xi_1}{d_{12}} \left\{ \log(r_2 - s_2) - \log(r_1 - s_1) \right\}$$

$$= \frac{\xi_2 - \xi_1}{d_{12}} \log \frac{(r_2 - s_2)}{(r_1 - s_1)} \qquad (52)$$

The quantities r_1, r_2, s_1, and s_2 used in equation (52) are as shown in figure (13). Equation (52) is singular when $r_1 = s_1$, which occurs when the field point P is located anywhere along the line defined by the side of the quadrilateral. This singularity may be removed by using the law of cosines (Hess and Smith 1962).

$$\cos\alpha = \frac{b^2 + c^2 - a^2}{2bc}$$

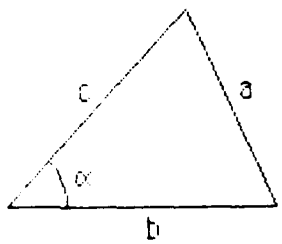


Figure 14. The law of cosines

From equation (52)

$$V_{y_{12}} = \frac{\xi_2 - \xi_1}{d_{12}} \log \frac{r_2(1 - \cos \beta_2)}{r_1(1 - \cos \beta_1)} \tag{53}$$

where β_1 and β_2 are the interior angles shown in figure (13). Applying the law of cosines to figure (13)

$$\cos \beta_1 = \frac{r_1^2 + d_{12}^2 - r_2^2}{2 r_1 d_{12}} \tag{54}$$

$$\cos \beta_2 = -\frac{r_2^2 + d_{12}^2 - r_1^2}{2 r_2 d_{12}} = \frac{r_1^2 - d_{12}^2 - r_2^2}{2 r_2 d_{12}} \tag{55}$$

From equations (54) and (55):

$$\frac{r_2(1 - \cos \beta_2)}{r_1(1 - \cos \beta_1)} = \frac{r_2 \left[1 - \dfrac{r_1^2 - d_{12}^2 - r_2^2}{2 r_2 d_{12}}\right]}{r_1 \left[1 - \dfrac{r_1^2 + d_{12}^2 - r_2^2}{2 r_1 d_{12}}\right]}$$

$$= \frac{r_2 \left[\dfrac{2 r_2 d_{12} - r_1^2 + d_{12}^2 + r_2^2}{2 r_2 d_{12}}\right]}{r_1 \left[\dfrac{2 r_1 d_{12} - r_1^2 - d_{12}^2 + r_2^2}{2 r_1 d_{12}}\right]}$$

$$= \frac{2 r_2 d_{12} - r_1^2 + d_{12}^2 + r_2^2}{2 r_1 d_{12} - r_1^2 - d_{12}^2 + r_2^2} = \frac{(r_2 + d_{12})^2 - r_1^2}{-(r_1 - d_{12})^2 + r_2^2}$$

$$= \frac{[(r_2 + d_{12}) + r_1]\,[(r_2 + d_{12}) - r_1]}{[r_2 + (r_1 - d_{12})]\,[r_2 - (r_1 - d_{12})]} = \frac{r_1 + r_2 + d_{12}}{r_1 + r_2 - d_{12}} \tag{56}$$

Substituting equation (56) into equation (53) yields the final form of the exact equation of the y component of the velocity induced by the side of the quadrilateral from point 1 to point 2:

$$V_{y_{12}} = \frac{\xi_2 - \xi_1}{d_{12}} \log \frac{r_1 + r_2 + d_{12}}{r_1 + r_2 - d_{12}} \tag{57}$$

Equation (57) is applied to the remaining sides of the quadrilateral simply by substituting the appropriate point numbers for the corner points of each side. The total contribution of the quadrilateral to the y component of the velocity is the sum of the four terms representing the contributions of each of the sides. The y component of the velocity at the field point P is now given by:

$$\begin{aligned} V_y = {} & \frac{\xi_2 - \xi_1}{d_{12}} \log \frac{r_1 + r_2 + d_{12}}{r_1 + r_2 - d_{12}} + \frac{\xi_3 - \xi_2}{d_{23}} \log \frac{r_2 + r_3 + d_{23}}{r_2 + r_3 - d_{23}} \\ & + \frac{\xi_4 - \xi_3}{d_{34}} \log \frac{r_3 + r_4 + d_{34}}{r_3 + r_4 - d_{34}} + \frac{\xi_1 - \xi_4}{d_{41}} \log \frac{r_4 + r_1 + d_{41}}{r_4 + r_1 - d_{41}} \end{aligned} \tag{58}$$

7.2 THE X VELOCITY COMPONENT

A similar derivation process is used to produce the equation for the x component of the velocity induced by the side of the quadrilateral from point 1 to point 2. The semi-infinite source strips are constructed parallel to the x axis, and the order of integration is reversed.

The x component of the velocity at the field point P due to the quadrilateral is given by:

$$V_x = \frac{\eta_2 - \eta_1}{d_{12}} \log \frac{r_1 + r_2 + d_{12}}{r_1 + r_2 - d_{12}} + \frac{\eta_3 - \eta_2}{d_{23}} \log \frac{r_2 + r_3 + d_{23}}{r_2 + r_3 - d_{23}}$$

$$+ \frac{\eta_4 - \eta_3}{d_{34}} \log \frac{r_3 + r_4 + d_{34}}{r_3 + r_4 - d_{34}} + \frac{\eta_1 - \eta_4}{d_{41}} \log \frac{r_4 + r_1 + d_{41}}{r_4 + r_1 - d_{41}} \qquad (59)$$

7.3 THE Z VELOCITY COMPONENT

The z component of the velocity at the field point P due to the quadrilateral is obtained in a similar fashion, using semi-infinite source strips, this time parallel to the y axis. From equation (46), the fundamental velocity potential of the semi infinite source strips is integrated in a manner similar to that used to obtain equation (47), and the z component of the velocity due to the side from (ξ_1, η_1) to (ξ_2, η_2) is given by

$$V_{z_{12}} = \int_{\xi_1}^{\xi_2} d\xi \left[\frac{1}{2} \int_{-\infty}^{\eta_{12}} - \frac{1}{2} \int_{\eta_{12}}^{\infty} \right] \frac{z \, d\eta}{r^3} \qquad (60)$$

$$V_{z_{12}} = \frac{z}{2} \int_{\xi_1}^{\xi_2} d\xi \left[\int_{-\infty}^{\eta_{12}} - \int_{\eta_{12}}^{\infty} \right] \frac{d\eta}{[(x-\xi)^2 + (y-\eta)^2 + z^2]^{3/2}}$$

Performing the integration with respect to η, the integral

$$\int \frac{d\eta}{[(x-\xi)^2 + (y-\eta)^2 + z^2]^{3/2}}$$

fits the integral form

$$-\int \frac{dF}{[C^2 + F^2]^n} = \frac{-1}{2C^2(n-1)} \left[\frac{F}{[C^2 + F^2]^{n-1}} + (2n-3) \int \frac{dF}{[C^2 + F^2]^{n-1}} \right]$$

where

$C^2 = (x - \xi)^2 + z^2$

$F = (y - \eta)$

$dF = -d\eta$

$n = 3/2$

Then, from equation (60)

$$\begin{aligned} V_{z_{12}} = -\frac{z}{2} \int_{\xi_1}^{\xi_2} d\xi \Bigg\{ & \frac{(y-\eta)}{[(x-\xi)^2 + z^2][(x-\xi)^2 + (y-\eta)^2 + z^2]^{1/2}} \Bigg|_{\eta_{12}} \\ & - \frac{(y-\eta)}{[(x-\xi)^2 + z^2][(x-\xi)^2 + (y-\eta)^2 + z^2]^{1/2}} \Bigg|_{-\infty} \\ & - \frac{(y-\eta)}{[(x-\xi)^2 + z^2][(x-\xi)^2 + (y-\eta)^2 + z^2]^{1/2}} \Bigg|_{\infty} \\ & - \frac{(y-\eta)}{[(x-\xi)^2 + z^2][(x-\xi)^2 + (y-\eta)^2 + z^2]^{1/2}} \Bigg|_{\eta_{12}} \Bigg\} \end{aligned} \qquad (61)$$

Again, the terms evaluated at $+\infty$ and $-\infty$ cancel and the terms evaluated at η_{12} add to obtain the following expression:

$$V_{z_{12}} = -z \int_{\xi_1}^{\xi_2} \frac{(y - \eta_{12})\, d\xi}{[(x-\xi)^2 + z^2][(x-\xi)^2 + (y-\eta_{12})^2 + z^2]^{1/2}} \qquad (62)$$

Without a convenient substitution with which to integrate equation (62), the integration is performed directly. Recognizing that along the line defined by the side of the quadrilateral from (ξ_1, η_1) to (ξ_2, η_2), η_{12} may be expressed as a function of ξ:

$$\eta_{12} = m_{12}\,\xi + b_{12} \tag{63}$$

where the slope of the side, m_{12} is given by

$$m_{12} = \frac{\eta_2 - \eta_1}{\xi_2 - \xi_1} \tag{64}$$

and b_{12} may be determined knowing that $\eta_{12} = \eta_1$ when $\xi = \xi_1$.

$$b_{12} = \frac{\xi_2\eta_1 - \xi_1\eta_2}{\xi_2 - \xi_1} \tag{65}$$

Substituting equation (63) into equation (62) yields

$$V_{z_{12}} = -z\int_{\xi_1}^{\xi_2} \frac{(y - m_{12}\xi - b_{12})\,d\xi}{[(x-\xi)^2 + z^2][(x-\xi)^2 + (y - m_{12}\xi - b_{12})^2 + z^2]^{1/2}} \tag{66}$$

Define the quantities

$$q_{12} = y - b_{12} - m_{12}x \tag{67}$$

$$u = x - \xi \tag{68}$$

Then $\quad du = -d\xi \qquad (69)$

$$y - b_{12} - m_{12}\xi = m_{12}u + q_{12} \tag{70}$$

By a change of variable, equation (66) is now expressed as a function of u:

$$V_{z_{12}} = z\int_{x-\xi_1}^{x-\xi_2} \frac{(m_{12}u + q_{12})\,du}{[u^2 + z^2][u^2 + (m_{12}u + q_{12})^2 + z^2]^{1/2}} \tag{71}$$

$$= z\int_{x-\xi_1}^{x-\xi_2} \frac{(m_{12}u + q_{12})\,du}{[u^2 + z^2][(m_{12}^2 + 1)u^2 + 2m_{12}q_{12}u + q_{12}^2 + z^2]^{1/2}} \tag{72}$$

which fits the form of

$$\int \frac{(Lu + M)\,du}{(Au^2 + 2Bu + C)\sqrt{(au^2 + 2bu + c)}} \tag{73}$$

where

$L = m_{12}$	$M = q_{12}$
$A = 1$	$a = (m_{12}^2 + 1)$
$B = 0$	$b = m_{12}q_{12}$
$C = z^2$	$c = q_{12}^2 + z^2$

From Hardy (1944), this integral form may be integrated by the substitution

$$u = \frac{\mu t + \upsilon}{t + 1} \tag{74}$$

where μ and υ satisfy

$$a\mu\upsilon + b(\mu + \upsilon) + c = 0 \tag{75}$$

$$A\mu\upsilon + B(\mu + \upsilon) + C = 0 \tag{76}$$

and are the roots of the equation

$$(aB - bA)\xi^2 - (cA - aC)\xi + (bC - cB) = 0 \tag{77}$$

Substituting the appropriate values into equation (75), the roots of the quadratic equation are

$$\mu = -\frac{q_{12}}{m_{12}} \tag{78}$$

$$\upsilon = \frac{m_{12} z^2}{q_{12}} \tag{79}$$

It can be verified that these values satisfy equations (75) and (76).

Substituting equations (78) and (79) into equation (74)

$$u = \frac{\dfrac{m_{12} z^2}{q_{12}} - \dfrac{q_{12} t}{m_{12}}}{t + 1} \tag{80}$$

$$du = \left[\frac{-\dfrac{q_{12} t}{m_{12}} - \dfrac{m_{12} z^2}{q_{12}}}{(t + 1)^2} \right] dt \tag{81}$$

By substitution and a change of variable, equation (72) becomes a function of the parameter t. After simplification, the integral now fits the form of

$$K \int \frac{dt}{(\alpha t^2 + \beta)\sqrt{(\gamma t^2 + \delta)}} \tag{82}$$

where

$K = -(m_{12}^6 q_{12} z^4 + 2m_{12}^4 q_{12}^3 z^2 + q_{12}^5 m_{12}^2)$

$\alpha = q_{12}^4 + m_{12}^2 q_{12}^2 z^2$

$$\beta = m_{12}^4 z^4 + m_{12}^2 q_{12}^2 z^2$$

$$\gamma = q_{12}^4 + m_{12}^2 q_{12}^2 z^2$$

$$\delta = m_{12}^6 z^4 + m_{12}^4 z^4 + 2m_{12}^4 q_{12}^2 z^2 + m_{12}^2 q_{12}^4 + m_{12}^2 q_{12}^2 z^2$$

Equation (82) can be rationalized by the substitution

$$v = \frac{t}{\sqrt{\gamma t^2 + \delta}} \tag{83}$$

from which it can be shown that

$$t^2 = \frac{v^2 \delta}{1 - v^2 \gamma} \tag{84}$$

$$dt = \left[\frac{\delta}{(1 - v^2 \gamma)^3} \right]^{1/2} dv \tag{85}$$

Substituting equations (84) and (85) into equation (82) and simplifying yields the integral in terms of the parameter v:

$$K \int \frac{dt}{(\alpha t^2 + \beta)\sqrt{(\gamma t^2 + \delta)}} = K \int \frac{dv}{\beta + (\alpha\delta - \beta\gamma)v^2} \tag{86}$$

which fits the form

$$\int \frac{dv}{a^2 + b^2 v^2} = \frac{1}{ab} \tan^{-1} \frac{bv}{a} \tag{87}$$

where $a^2 = \beta$

$b^2 = (\alpha\delta - \beta\gamma)$

Performing the integration

$$K \int \frac{dv}{\beta + (\alpha\delta - \beta\gamma)v^2} = \frac{K}{\sqrt{\beta(\alpha\delta - \beta\gamma)}} \tan^{-1}\left[v \sqrt{\frac{\alpha\delta - \beta\gamma}{\beta}} \right] \qquad (86)$$

From equations (80), (83), and the expressions for α, β, δ, and γ from equation (82), and after a considerable amount of algebraic manipulation and simplification, equation (88) becomes

$$\frac{K}{\sqrt{\beta(\alpha\delta - \beta\gamma)}} \tan^{-1}\left[v \sqrt{\frac{\alpha\delta - \beta\gamma}{\beta}} \right]$$

$$= -\frac{1}{z} \tan^{-1}\left[\frac{m_{12} z^2 - q_{12} u}{z\sqrt{z^2 + u^2 + (m_{12} u + q_{12})^2}} \right] \qquad (89)$$

From equations (63) and (67), equation (89) becomes

$$-\frac{1}{z} \tan^{-1}\left[\frac{m_{12} z^2 - q_{12} u}{z\sqrt{z^2 + u^2 + (m_{12} u + q_{12})^2}} \right]$$

$$= -\frac{1}{z} \tan^{-1}\left[\frac{m_{12}(u^2 + z^2) - (y - \eta_{12}) u}{z\sqrt{u^2 + (y - \eta_{12})^2 + z^2}} \right] \qquad (90)$$

Finally, applying these results to equation (71)

$$V_{z_{12}} = z\int_{x-\xi_1}^{x-\xi_2} \frac{(m_{12}u + q_{12})\,du}{[u^2+z^2][u^2+(m_{12}u+q_{12})^2+z^2]^{1/2}}$$

$$= -\tan^{-1}\left[\frac{m_{12}(u^2+z^2)-(y-\eta_{12})u}{z\sqrt{u^2+(y-\eta_{12})^2+z^2}}\right]\Bigg|_{x-\xi_1}^{x-\xi_2}$$

$$= \tan^{-1}\left[\frac{m_{12}((x-\xi_1)^2+z^2)-(y-\eta_{12})(x-\xi_1)}{z\sqrt{(x-\xi_1)^2+(y-\eta_{12})^2+z^2}}\right]$$
$$-\tan^{-1}\left[\frac{m_{12}((x-\xi_2)^2+z^2)-(y-\eta_{12})(x-\xi_2)}{z\sqrt{(x-\xi_2)^2+(y-\eta_{12})^2+z^2}}\right] \qquad (91)$$

Recall that when $x = \xi_1$, $y = \eta_1$ and when $x = \xi_2$, $y = \eta_2$. Then, for the sake of a more compact equation, define the following quantities:

$$e_1 = (x-\xi_1)^2 + z^2 \qquad e_2 = (x-\xi_2)^2 + z^2$$
$$h_1 = (y-\eta_1)(x-\xi_1) \qquad h_2 = (y-\eta_2)(x-\xi_2)$$

The quantities r_1 and r_2 are as shown in figure (12), where

$$r_1 = \sqrt{(x-\xi_1)^2+(y-\eta_1)^2+z^2} \qquad r_2 = \sqrt{(x-\xi_2)^2+(y-\eta_2)^2+z^2}$$

Substituting these quantities into equation (91) yields the exact z component of velocity due to the side from point (ξ_1,η_1) to (ξ_2,η_2) in the form used by the XYZ Potential Flow Program:

$$V_{z_{12}} = \tan^{-1}\left[\frac{m_{12}e_1 - h_1}{z\,r_1}\right] - \tan^{-1}\left[\frac{m_{12}e_2 - h_2}{z\,r_2}\right] \qquad (92)$$

The total z component of the velocity at the field point P(x, y, z) due to the quadrilateral element is the sum of the four sides:

$$
\begin{aligned}
V_z = &\tan^{-1}\left[\frac{m_{12}e_1 - h_1}{z\,r_1}\right] - \tan^{-1}\left[\frac{m_{12}e_2 - h_2}{z\,r_2}\right] \\
&+ \tan^{-1}\left[\frac{m_{23}e_2 - h_2}{z\,r_2}\right] - \tan^{-1}\left[\frac{m_{23}e_3 - h_3}{z\,r_3}\right] \\
&+ \tan^{-1}\left[\frac{m_{34}e_3 - h_3}{z\,r_3}\right] - \tan^{-1}\left[\frac{m_{34}e_4 - h_4}{z\,r_4}\right] \\
&+ \tan^{-1}\left[\frac{m_{41}e_4 - h_4}{z\,r_4}\right] - \tan^{-1}\left[\frac{m_{41}e_1 - h_1}{z\,r_1}\right]
\end{aligned}
\qquad (93)
$$

8.0 APPROXIMATIONS OF THE INDUCED VELOCITY

8.1 QUADRUPOLE METHOD

As previously mentioned, as the ratio of (r_0/t) exceeds the value of 2, then certain approximations may be made which greatly reduce the calculation effort otherwise required by the exact method. In the range of $2 < (r_0/t) \leq 4$, the XYZ Potential Flow Program uses the second order approximation of the potential described by equation (43). With the origin at the centroid of the quadrilateral, the first moments are zero, and the second order approximation is

$$\varphi = Aw + (1/2)(I_{xx}w_{xx} + 2I_{xy}w_{xy} + I_{yy}w_{yy}) \qquad (94)$$

where the first term is a point source of strength A, the second term is composed of three quadrupoles of strengths I_{xx}, I_{xy}, and I_{yy} located at the local origin, and the subscripts on w indicate the partial derivatives of w with respect to those variables as before. The quantity A is the area of the element, and the terms I_{xx}, I_{xy}, and I_{yy} are the respective moments of inertia of the source element given by equations (39), (40), and (41). To obtain the velocity components at the field point, equation (94) is differentiated with respect to the coordinate directions giving:

$$V_x = -\frac{\partial \varphi}{\partial x} = -\left[A w_x + \frac{1}{2} I_{xx} w_{xxx} + I_{xy} w_{xxy} + \frac{1}{2} I_{yy} w_{xyy} \right] \quad (95)$$

$$V_y = -\frac{\partial \varphi}{\partial y} = -\left[A w_y + \frac{1}{2} I_{xx} w_{xxy} + I_{xy} w_{xyy} + \frac{1}{2} I_{yy} w_{yyy} \right] \quad (96)$$

$$V_z = -\frac{\partial \varphi}{\partial z} = -\left[A w_z + \frac{1}{2} I_{xx} w_{xxz} + I_{xy} w_{xyz} + \frac{1}{2} I_{yy} w_{yyz} \right] \quad (97)$$

Recalling that $w = \frac{1}{\sqrt{x^2 + y^2 + z^2}} = \frac{1}{r_0}$

the derivatives of w, as expressed by Hess and Smith (1962) and as used in the XYZPF program, are

$$\left.\begin{aligned} w_x &= -x\, r_0^{-3} \\ w_y &= -y\, r_0^{-3} \\ w_z &= -z\, r_0^{-3} \end{aligned}\right\} \quad (99)$$

$$\left.\begin{aligned} w_{xxx} &= 3x(3p + 10x^2)\, r_0^{-7} \\ w_{xxy} &= 3y\, p\, r_0^{-7} \\ w_{xyy} &= 3x\, q\, r_0^{-7} \\ w_{yyy} &= 3y(3q + 10y^2)\, r_0^{-7} \\ w_{xxz} &= 3z\, p\, r_0^{-7} \\ w_{xyz} &= -15xyz\, r_0^{-7} \\ w_{yyz} &= 3z\, q\, r_0^{-7} \end{aligned}\right\} \quad (100)$$

where

$$p = y^2 + z^2 - 4x^2$$
$$q = x^2 + z^2 - 4y^2$$

8.2 MONOPOLE METHOD

When the ratio of (r_0/t) is greater than 4, then the quadrilateral may be approximated by a simple source corresponding to the first term of equation (43). Then the velocity components at the field point due to the quadrilateral are given by

$$V_x = -\frac{\partial \varphi}{\partial x} = -Aw_x \tag{101}$$

$$V_y = -\frac{\partial \varphi}{\partial y} = -Aw_y \tag{102}$$

$$V_z = -\frac{\partial \varphi}{\partial z} = -Aw_z \tag{103}$$

where the partial derivatives of w are those given in equation (99).

9.0 SOLVING THE MATRIX EQUATION FOR SOURCE DENSITY

9.1 JACOBI'S ITERATIVE METHOD

From equation (20), the matrix equation may be solved for the constant source density σ_i for each element which satisfies the boundary condition equation (11). Equation (20) suggests the use of Jacobi's iterative method of matrix solution in the form

$$\sigma_i^{(m+1)} = V_i + \sum_{\substack{j=1 \\ j \neq i}}^{N} C_{ij} \sigma_j^{(m)} , \quad i = 1, 2, \ldots, N \qquad (104)$$

where N is the number of elements composing the body surface, and m is the number of iterations completed. A partial sum of equation (104) is computed for each of the ith elements before proceeding to the next jth element. The iteration is complete when the summation of equation (104) includes all of the jth elements. Because the values of the source densities at all of the elements are recomputed before any of them are used in the iteration, this method is also called the simultaneous displacement method (Ralston 1965). This is contrasted with the Gauss-Seidel iterative method used in the Douglas program. In the Gauss-Seidel method, as each new σ_i is computed, it is used immediately in the iteration process for calculation of $\sigma_{(i+1)}$. This is also known as the successive displacement method and is expressed as

$$\sigma_i^{(m+1)} = V_i + \sum_{j=1}^{i-1} C_{ij}\sigma_j^{(m+1)} + \sum_{j=i+1}^{N} C_{ij}\sigma_j^{(m)} \qquad (105)$$

$$i = 1, 2, \ldots, N$$

Though the Gauss-Seidel iterative method is faster, the Jacobi iteration method was selected for use in the XYZPF program in order to be able to perform the iterations column by column, since the coefficient matrix is also computed column by column, and the matrix does not have to be transposed for solution.

When the (m+1)th iteration is complete, the values of the source densities are compared with those of the (m)th iteration and the differences summed for all of the elements. The total difference between successive iterations is then compared to a convergencecriteria input by the user. If the difference is less than the convergencecriteria, then the matrix solution is complete and the values of the source densities are stored for later use in computing velocities and pressure coefficients. If the convergencecriteria is not met, then the iteration process is repeated. After every five iterations, if the convergencecriteria is still not met, then an extrapolation is attempted in order to accelerate the convergence. The XYZ Potential Flow Program uses a Richardson extrapolation method, a numerical procedure which uses two approximate results to obtain a third approximation which is closer to the exact solution (Ralston 1965).

9.2 RICHARDSON EXTRAPOLATION

The Richardson extrapolation assumes that the iterative process is convergent. For the iterative solutions S_0, S_1, and S_2, where S_0 is the most recent approximation and S_2 the oldest, the solution is convergent if

$$\frac{S_0 - S_1}{S_1 - S_2} = \lambda < 1 \qquad (106)$$

While a Richardson-type extrapolation can take may forms, the XYZPF program uses a procedure developed from the following approximations (Dawson and Dean 1972). If there is only one dominant eigenvalue and a sufficient number of iterations have been completed, the iterative solutions may be approximated by

$$\begin{aligned} S_0 &\approx S_f + E\,\lambda^{m} \\ S_1 &\approx S_f + E\,\lambda^{m-1} \\ S_2 &\approx S_f + E\,\lambda^{m-2} \\ S_i &\approx S_f + E\,\lambda^{m-i} \end{aligned} \qquad (107)$$

where S_f is the true solution

λ is the eigenvalue

E is the eigenfunction

m is the number of completed iterations

Define the linear combination which, from equation (107), may be

approximated as

$$A S_0 + (1 - A) S_1 \approx S_f + E \lambda^{n-1} (A\lambda + 1 - A) \qquad (108)$$

The value of A may be chosen such that

$$(A\lambda + 1 - A) = 0 \qquad (109)$$

Then, from equations (108) and (109)

$$A S_0 + (1 - A) S_1 \approx S_f \qquad (110)$$

where the expression on the left converges to the exact solution. From equations (106) and (109)

$$\lambda = \frac{S_0 - S_1}{S_1 - S_2} = 1 - \frac{1}{A} \qquad (111)$$

Solving for A,

$$A = \frac{S_2 - S_1}{S_0 - 2S_1 + S_2} = \frac{S_2 - S_1}{D} \qquad (112)$$

Since the value of A generally changes from element to element, a weighted average of A is used in the extrapolation, where

$$\bar{A} = \frac{\sum_{i=1}^{N} (S_2(i) - S_1(i)) (\text{sign of } D(i))}{\sum_{i=1}^{N} D(i)} \qquad (113)$$

Equation (113) is recomputed after every fifth iteration. If the difference between the new value and the old value is less than 0.02, then the solution is extrapolated. From equation (110), the extrapolated solution is

$$S^* = \bar{A} S_0 + (1 - \bar{A}) S_1 \qquad (114)$$

When there are two dominant eigenvalues, then the iterative solutions may be approximated by

$$S_i \approx S_f + E_1 \lambda_1^{m-i} + E_2 \lambda_2^{m-i} \tag{115}$$

where S_f is the true solution

λ_1 and λ_2 are the eigenvalues

E_1 and E_2 are the eigenfunctions

m is the number of completed iterations

Define the linear combination which, from equation (115), may be approximated as

$$\begin{aligned} &B_2 S_0 + B_1 S_1 + (1 - B_1 - B_2) S_2 \\ &\approx S_f + E_1 \lambda_1^{m-2} [B_2 \lambda_1^2 + B_1 \lambda_1 + (1 - B_1 - B_2)] \\ &\qquad + E_2 \lambda_2^{m-2} [B_2 \lambda_2^2 + B_1 \lambda_2 + (1 - B_1 - B_2)] \end{aligned} \tag{116}$$

The values of B_1 and B_2 may be determined for which the eigenvalues λ_1 and λ_2 are roots of the quadratic equation

$$B_2 \lambda^2 + B_1 \lambda + (1 - B_1 - B_2) = 0 \tag{117}$$

Then, from equation (116)

$$B_2 S_0 + B_1 S_1 + (1 - B_1 - B_2) S_2 \approx S_f \tag{118}$$

where the left side of the equation (118) converges to the exact solution. Using equation (115) and eliminating terms containing E_2:

$$
\begin{aligned}
(S_0 - S_1) - \lambda_2 (S_1 - S_2) &= E_1 \lambda_1^{n-2}(\lambda_1 - \lambda_2)(\lambda_1 - 1) \\
(S_1 - S_2) - \lambda_2 (S_2 - S_3) &= E_1 \lambda_1^{n-3}(\lambda_1 - \lambda_2)(\lambda_1 - 1) \qquad (119) \\
(S_2 - S_3) - \lambda_2 (S_3 - S_4) &= E_1 \lambda_1^{n-4}(\lambda_1 - \lambda_2)(\lambda_1 - 1)
\end{aligned}
$$

Solving for λ_1

$$\lambda_1 = \frac{(S_0 - S_1) - \lambda_2 (S_1 - S_2)}{(S_1 - S_2) - \lambda_2 (S_2 - S_3)} = \frac{(S_1 - S_2) - \lambda_2 (S_2 - S_3)}{(S_2 - S_3) - \lambda_2 (S_3 - S_4)} \qquad (120)$$

From equations (117) and (120)

$$B_1 = \frac{(S_4 - S_3)(S_0 - 2S_2 + S_4) - (S_4 - S_2)[(S_1 - S_2) - (S_3 - S_4)]}{D} \qquad (121)$$

$$B_2 = \frac{(S_4 - S_2)(S_4 - 2S_3 + S_2) - (S_4 - S_3)[(S_1 - S_2) - (S_3 - S_4)]}{D} \qquad (122)$$

where $\qquad D = (S_4 - 2S_3 - S_2)(S_0 - 2S_2 + S_4) - (S_1 - S_2 - S_3 + S_4)^2$

The weighted averages of B_1 and B_2 are used for the extrapolation as done with A in equation (113). If the sum of the absolute values of the weighted averages of B_1 and B_2 changes by less than 2%, then the extrapolation is performed. Then from equation (118), the extrapolated solution is

$$S^* = \overline{B}_2 S_0 + \overline{B}_1 S_1 + (1 - \overline{B}_1 - \overline{B}_2) S_2 \qquad (123)$$

10.0 CALCULATION OF VELOCITIES AND PRESSURE COEFFICIENTS

With the influence coefficients and the source densities determined, the calculation of velocities is a relatively simple matter. From equation (9), the total velocity is the sum of the freestream velocity and the disturbance velocity due to the body. The product of the source densities and the influence coefficients are summed for all of the elements, and then added to the freestream velocity to determine the total velocity at any point in the domain. Velocities on the surface of the body are calculated at the null points only, as the boundary conditions are enforced only at the null point of each element, and velocities at other points in the element would produce significant error due to the method of approximation. The components of the velocity at the centroid of the ith element are

$$\begin{aligned} V_{i_x} &= V_{\infty_x} + \sum_{j=1}^{N} C_{ij_x}\sigma_j \\ V_{i_y} &= V_{\infty_y} + \sum_{j=1}^{N} C_{ij_y}\sigma_j \qquad (124) \\ V_{i_z} &= V_{\infty_z} + \sum_{j=1}^{N} C_{ij_z}\sigma_j \end{aligned}$$

From equation (15), the velocity induced by an element at its own null point has a magnitude of 2π directed along the outward normal vector of the element.

At a point off the surface of the body, the components of the velocity are determined just as if the point of interest was a null point of a single element. The total velocity at the field point is the sum of the freestream velocity and the contributions of each of the elements of the body surface. The contribution of each of the elements is determined by calculating the influence coefficient based on the element geometry, and multiplying the result by the source density for the element. The total velocity at the field point may be expressed as

$$\mathbf{V}_p = \mathbf{V}_\infty + \sum_{q=1}^{N} C_{pq}\ \sigma_q \qquad (125)$$

where p and q represent the field point and the source element respectively and the influence coefficient,

$$C_{pq} = \iint \frac{\partial}{\partial n}\left[\frac{1}{r(p,q)}\right] d\Gamma \qquad (126)$$

As discussed in section 6.0, the influence coefficient may be calculated by the exact method, or it may be approximated by the quadrupole or monopole method depending on the ratio of the distance, r_0, between the field point and the centroid of the source element to the maximum dimension, t, of the source element.

The magnitude of the velocity at either the on-body or off-body points is given by

$$\left|\mathbf{V}\right| = \sqrt{V_x^2 + V_y^2 + V_z^2} \tag{127}$$

The pressure coefficient is calculated by using the result of equation (127) in equation (19), renumbered here for clarity.

$$C_p = \frac{p - p_\infty}{\frac{1}{2}\rho\left|\mathbf{V}_\infty\right|^2} = 1 - \frac{\left|\mathbf{V}\right|^2}{\left|\mathbf{V}_\infty\right|^2} \tag{128}$$

11.0 STREAMLINE CALCULATIONS

For the calculation of streamlines off the surface of the body, a timestep procedure is performed by calculating the velocity at the starting point of the streamline from equation (125), and advancing the streamline one time increment by a fourth order Runge-Kutta integration to a new point (Ralston 1965). The timestep procedure is repeated, thus creating a streamline composed of finite segments.

For the calculation of streamlines on the surface of the body, the streamline is started at a specified point and quadrilateral number. The local velocity is calculated from equation (124), and the values of a stream function are computed for each corner point. The stream function is chosen so that it has a value of zero at the last point on the streamline in the quadrilateral. The side of the quadrilateral through which the streamline exits is determined, and coordinates of the point on the side which has a stream function value of zero are computed. The direction of the streamline is verified by comparing it with the known direction of positive velocity. The next quadrilateral through which the streamline passes is determined by calculating the proximity of the new quadrilateral to the most recent point on the streamline. A circular area is computed which encloses the new quadrilateral with an additional 10% margin. If the last point of the streamline falls outside the circle, then the quadrilateral is discarded and a new one selected until the streamline is adjacent to the new quadrilateral.

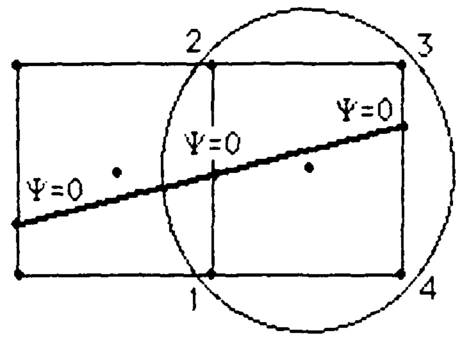


Figure 15. Calculation of on-body streamlines

This procedure is repeated along the surface of the body until all of the surface elements have been tested. The result is a streamline composed of segments from one side of an element to another.

12.0 DEVELOPMENT OF HIGHER ORDER PANEL METHODS

The XYZ Potential Flow program assumes a constant element source panel as described in Section 3.3. Extensive use of the constant element source panel method has shown that the primary diasadvantage of the method is that, in order to obtain a highly accurate solution, a large number of surface elements must be used to discretize the body surface. The method has been applied to problems of increasingly complex configurations (Hess 1977). By doing so, the size of the coefficient matrix is increased resulting in increased computer time and cost. Additional cost is accrued due to the manhours required to prepare the input. Therefore, while the constant element methods have proven to be very successful, the cost has motivated the development of higher order methods.

The higher order surface singularity methods discretize the body surface with curved elements having a variable source density, as compared to the flat elements of constant source strength used in the basic method. Hess (1973) showed that the effect of a curved surface and the effect of a variable source density are of the same order of magnitude. Therefore, the two effects must be used together to provide a "consistent" solution. The consistent higher order panel method provides the increased accuracy and speed desired for three dimensional Neumann problems (Hess 1979).

According to Hess (1979), the evolution of the higher order panel

method from the constant element method involved the derivation of new influence coefficients based on the integration of a variable source density over a curved element. Other portions of the method were unchanged. However, the development of the higher order velocity equations also required different programming logic.

In examining the potential for development of the higher order methods, Hess (1979) noted that "a consistent approach always uses a source polynomial one degree less than the panel polynomial." Through an independent effort, Brebbia (1984) presented a higher order approach using the direct method to solve for a surface potential polynomial stating that the potential function must be of a degree at least equal to the degree of the polynomial describing the element. Knowing that the velocity function is the derivative of the potential function, these two observations agree. As a result of his derivations, Hess showed that the solution of a flat element with a constant source requires one integral, a paraboloidal panel with a linearly varying source density requires six integrals, and a cubic element with a quadratic source density requires twenty-three integrals. Development of higher order methods has focused on the paraboloidal element with the linearly varying surface, as solutions of higher order than that offered little benefit for the amount of effort required to produce a working program (Hess 1979). Hess (1979) and Eriksson (1983) have independently developed programs for three dimensional higher order panel methods. The higher order Hess program evolved from the constant element program which he developed in the early 1960s, while Eriksson developed a new program based on the

work of Johnson and Rubbert (1975). Continued work in the near future is expected to deal primarily with refinement of the paraboloidal element with a linearly varying source (Eriksson 1983).

In order to alleviate the burden of preparing the input, a geometry package for input data generation has been developed which is incorporated into the Hess higher order panel program. This allows the user to enter relatively few points to describe the body. The geometry package enhances the surface representation by distributing additional points on the surface based on one of many algorithms or recurring geometries (Halsey 1978).

As the state of the art in fluid dynamics has progressed, the XYZ Potential Flow program has seen increasingly complex applications requiring a great deal of effort in preparing the input, and requiring long computer run times. Hess (1979) reported the use of the Hess constant element program for a configuration utilizing 7000 effective elements. Realizing that the computation time increases as the square of the number of elements, it is easy to see the motivation for developing the higher order panel methods. Though modern computers offer storage capacities which can handle most applications of the constant element method, the higher order panel methods can provide equal accuracy for much less user effort. While the constant element method is still a versatile tool, future generations of the surface singularity methods will be able to handle the more complex applications being demanded in fluid dynamics.

13.0 VELOCITY CALCULATIONS FOR A TRIAXIAL ELLIPSOID

As the only true body for which an analytical solution exists, a triaxial ellipsoid was selected for the sample calculations in order to compare calculated results with the analytical solution. Hess has made use of the triaxial ellipsoid throughout his works in developing both the constant element method and the higher order panel method. Therefore, the XYZPF program will be compared with existing results of the Hess method (Hess 1979).

The triaxial ellipsoid utilized for the calculations has semiaxes dimensions of 1, 2, and 0.5 in the x, y, and z directions respectively. The surface was discretized by selecting fixed intervals of 0.1 in the y direction, and fourteen equal divisions of the 90° sector in the x-z plane. The values of x and z were then solved in terms of y and an angle θ. This method yielded 280 elements in the first octant for a total of 2240 effective elements after employing symmetry. A FORTRAN program was used to generate the corner points and to prepare the input file for later use by the XYZPF program.

Figures (16) and (17) show excellent correlation with the analytical solution and little difference from the Hess solution using 4320 effective elements. The use of the centroid as the control point is an approximation used to simplify the multipole expansion of the potential about the origin of the local coordinate system. This approximation is valid for most elements. However, for elements which are long and thin,

the physical difference between the centroid location and the null point location is significant, and use of the centroid can produce significant error as may be observed in figure (16) when the value of y approaches 2.0.

Recent calculations on the same body (Hess 1979) showed that results of at least equal accuracy could be obtained using only 480 effective elements using the higher order panel method. These results are a significant demonstration of the value of the higher order panel method. Using the higher order panel method rather than the constant element method, the user has the option of obtaining equal accuracy with cruder discretization or higher accuracy for the same discretization effort. While the results of the triaxial ellipsoid show relatively little improvement in accuracy, the most significant advantages of the higher order panel method are evident for a body with concave regions (Hess 1977).

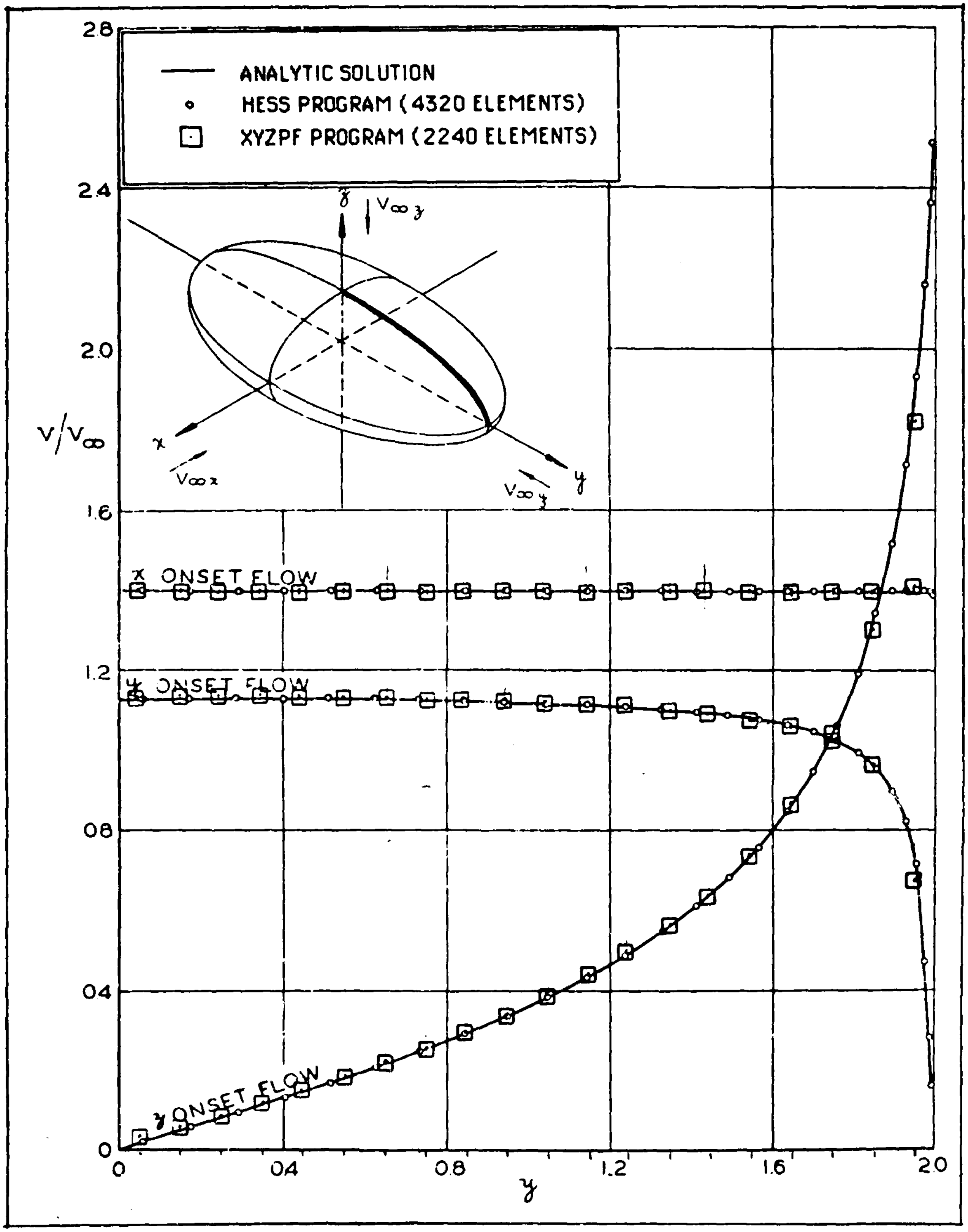


Figure 16. Comparison of analytic and calculated velocity distributions on an ellipsoid with axes ratios 1:2:0.5. Velocities in the xz-plane. (from Hess and Smith 1962)

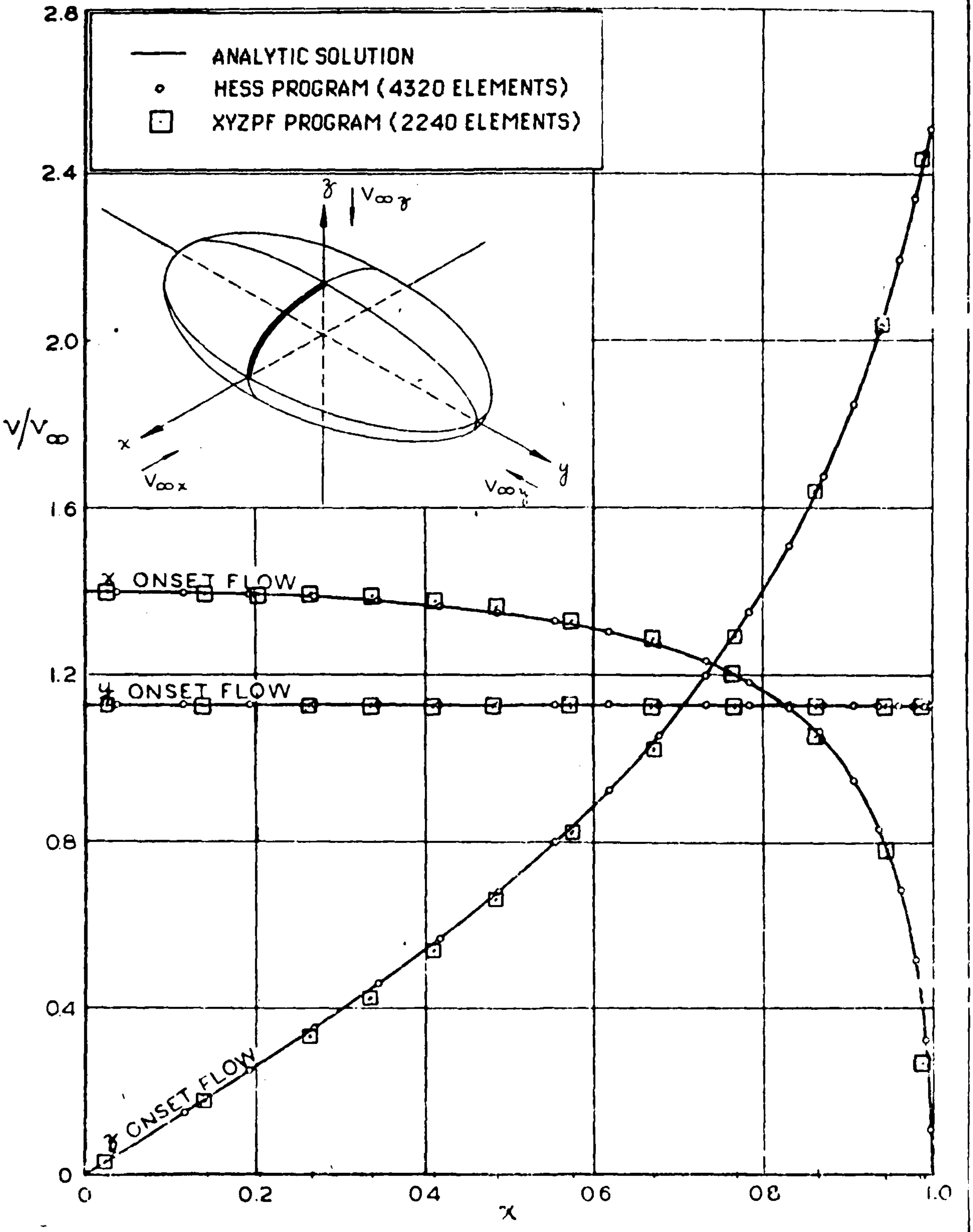


Figure 17. Comparison of analytic and calculated velocity distributions on an ellipsoid with axes ratios 1:2:0.5. Velocities in the yz-plane. (from Hess and Smith 1962)

14.0 CONCLUSION AND REMARKS

The objectives of this paper were (1) to describe the details of the approximation of an arbitrary three-dimensional body using quadrilateral elements, and (2) to provide a detailed derivation of the exact source panel integrations. Both of these objectives were met.

The method of surface discretization and source panel geometry is easily described using basic principles of geometry and vector algebra. By using quadrilateral surface elements, many surfaces can be discretized in a very straight forward logical fashion. The user can frequently visualize the contour lines of the surface which may be used to form the quadrilaterals, with some help from an intuitive approach to the fluid dynamics problem. The method of forming the planar quadrilateral element in the XYZPF Program differs slightly from the method presented by Hess and Smith (1962). The differences lie in the formation of the local coordinate system and the use of the centroid rather than the null point as the control point for applying the boundary conditions. The method of forming the local coordinate system has no effect on the potential flow calculations as long as one of the coordinate vectors is the outer normal to the planar element. The use of the centroid as the control point is an approximation used to simplify the multipole expansion of the potential about the origin of the local coordinate system. This approximation is valid for most elements. However, for elements which are long and thin, the physical difference between the centroid location and the null point location is significant, and use of the

centroid can produce significant error as may be observed in figure (16) when the value of y approaches 2.0.

A detailed derivation of the exact source panel integration has not previously appeared in literature, though the results are summarized by Hess and Smith (1962). The derivations presented in this paper verify the equations presented by Hess and Smith (1962), and the equations used in the XYZPF Program. The integral expressions for the velocity components were evaluated exactly with no assumptions or approximations used in the course of the integrations. Since the method of integration reduces the surface integral to a line integral around each of the sides of the element, the integration method can be generalized for a planar element with any number of sides, though the surface discretization used in the XYZPF Program uses only quadrilateral elements.

The calculation of potential flow about arbitrary three dimensional bodies is an engineering tool which is basic to design involving fluid dynamics. The XYZPF Program is a useful tool which has proven its value over the past 14 years. However, the increasing demands placed on this method are exposing the errors of the approximation as evident in the sample calculations presented in this paper. The requirement for increased accuracy has motivated the development of the higher order panel methods. Some of the limitations imposed on the XYZPF Program were due to computer memory and speed limitations. Advances in computer performance may allow future investigators to eliminate some

of the simplifying approximations used in the XYZPF Program, allowing increased accuracy without violating computer limitations. Some modifications might include the use of the null point as the control point rather than the panel centroid (as is used in the Hess program), or extending the range in which the exact velocity calculations are performed. The gains in accuracy by modifying the "constant element method" are limited by the basic approximations of the planar element and the constant source density for each element. Significant gains are most evident in the higher-order panel methods. This author concurs with Eriksson (1983) in expecting advances in the surface singularity methods to focus on the "development and refinement" of the higher order panel methods.

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APPENDICES

```
      PROGRAM PFP1(INPUT=128,OUTPUT=128,TAPE5=INPUT,TAPE6=OUTPUT,TAPE03,
     1            TAPE3=TAPE03,TAPE04,TAPE4=TAPE04,TAPE50=128)
C
C     XYZ POTENTIAL FLOW PROGRAM  VERSION 4  SECTION 1
C     READS INPUT AND COMPUTES QUADRILATERAL PARAMETERS
C
C     FOR INFORMATION CONTACT
C         BILL CHENG OR JANET DEAN
C         NUMERICAL FLUID DYNAMICS BRANCH    CODE 1843
C         NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER
C         BETHESDA, MARYLAND   20084
C
      DIMENSION INDEX(9,3),G(9,6),F(9),CZ(9),IP(9),XP(9),YP(9),ZP(9)
     1           ,MSK(100), WS(240),PROB(15),DM(650)
      COMMON    X(800 ),Y(800 ),Z(800 ),ID(41,71),B(250),T(4600),KP(100)
      EQUIVALENCE  (CZ(1),F(1) )
      EQUIVALENCE(WS(1),KP(1)),(WS(101),MSK(1)),(WS(201),NP ),(WS(202),
     2 NSP),(WS(203),NEP),(WS(204),NSE),(WS(205),MIX),(WS(206),MIY),
     3 (WS(207),MIZ),(WS(209),ICVM),(WS(210),ISM),(WS(211),K),(WS(213),
     4 EPS),(WS(208),IPS ),(WS(212),IPF ),(WS(217),XI),(WS(218),YI),
     5(WS(219),ZI)
      EQUIVALENCE (Y12,Y23),(Y34,Y41)
      INTEGER P,P1,P2,P3,P4,PC,P5,P6,P7,P8  ,P9
      WRITE (6,5)
    5 FORMAT(49H1XYZ POTENTIAL FLOW PROGRAM SECTION 1, VERSION 4   )
   10 FORMAT (I1,15A4)
   20 FORMAT (1X,15I4)
   50 FORMAT (1X,2I7,6E12.5)
   30 FORMAT (1X,5F12.9)
C       A.  READ IN CONTROL PARAMETERS
      WS(220)=4.
      K1=0
      ID1=0
      ID2=0
      ID3=0
      ID4=0
      ID5=0
      ID6=0
      ID7=0
      MAXN=70
      MAXM=40
      MAXNQE=650
      MAXPC=800
      ICNTRL=1
      EOF50=0.
      READ  (5 ,10)J,(PROB(I),I=1,15)
      IF (EOF(5) .EQ. 0.)  GO TO  9
      WRITE(6, 8)
    8 FORMAT(39HONO TITLE CARD FOUND - PROGRAM ABORTED   )
      STOP
    9 CONTINUE
      J=0
      WRITE (6,10) J,(PROB(I),I=1,15)
      SA=.0
      SB=0.
   21 FORMAT (17HONO. OF QUADS.  =,I4     /17H NO. OF SECTIONS=,
     2I4/31H MAX. NO. OF ITERATIONS X FLOW ,I3,9H  Y FLOW ,
     3I3,9H  Z FLOW ,I3)
      READ (5 ,11)NQE,NSE,MIX,MIY,MIZ,ISM,EPS,IUCT,IPS,IPF,ISP
```

```
     1      ,IEDIT1,IEDIT3,IEDIT4,ITAPE,XCENTER,YCENTER,ZCENTER
  11 FORMAT(6I4,F8.5,8I4,1X,3F5.3)
     IF (EOF(5) .EQ. 0.)  GO TO 19
     WRITE(6,18)
  18 FORMAT(43H0NO PARAMETER CARD FOUND - PROGRAM ABORTED     )
     STOP
  19 CONTINUE
     IF (IEDIT1.EQ.1)  ICNTRL=0
     WRITE (6,21) NQE,NSE,MIX,MIY,MIZ
  31 FORMAT ("CONVERGENCE CRITERIA",F8.5)
  41 FORMAT (4H0  M,7X,2HX1,12X,2HX2,12X,2HX3,12X,2HX4,12X,2HXP,12X,
    1 2HXN,12X,1HA,13X,3HCZ4/4H   N,7X,2HY1,12X,2HY2,12X,2HY3,12X,2HY4,
    2 12X,2HYP,12X,2HYN,12X,2HFL,12X,3HCZ5/4H   P,7X,2HZ1,12X,2HZ2,12X,
    3 2HZ3,12X,2HZ4,12X,2HZP,12X,2HZN,12X,4HCZ1 ,10X,3HCZ6/)
  42 FORMAT (4H1  M,7X,2HX1,12X,2HX2,12X,2HX3,12X,2HX4,12X,2HXP,12X,
    1 2HXN,12X,1HA,13X,3HCZ4/4H   N,7X,2HY1,12X,2HY2,12X,2HY3,12X,2HY4,
    2 12X,2HYP,12X,2HYN,12X,2HFL,12X,3HCZ5/4H   P,7X,2HZ1,12X,2HZ2,12X,
    3 2HZ3,12X,2HZ4,12X,2HZP,12X,2HZN,12X,4HCZ1 ,10X,3HCZ6/)
  24 FORMAT (1H ,I1,19H PLANES OF SYMMETRY)
 240 WRITE (6,24) ISM
 270 WRITE (6,31) EPS
 280 IF (IPS.LE.0) GO TO 290
 285 WRITE (6,36) IPS,IPF
  36 FORMAT (45H0NEW SOURCE DENSITY TO BE COMPUTED FOR QUADS.,I4,3H - ,
    1I4)
 290 K=0
     WRITE(6,39)ISP
  39 FORMAT (9H0     ISP = ,I3 )
     WRITE(6,37) IEDIT1,IEDIT3,IEDIT4,ITAPE
  37 FORMAT (9H0IEDIT1 =,I3/9H IEDIT3 =,I3/9H IEDIT4 =,I3/9H ITAPE  =,
    1         I3)
     WRITE(6,38)  XCENTER,YCENTER,ZCENTER
  38 FORMAT(10H0XCENTER = ,F5.2/10H YCENTER =,F5.2/10H ZCENTER =,F5.2)
     MM=0
     MN=0
     P=1
     Q=1.0
     DO 291 I=1,41
     DO 291 J=1,71
 291 ID(I,J)=0
     J=0
C      B.  READ FIRST PT.
     IERR=0
     IF (ITAPE.EQ.1)  GO TO 292
2000 READ (5,40) XI,YI,ZI,NI,MI,NS,NE,VN
     IF (EOF(5).NE.0.  .OR.  NS.LE.0)  GO TO 2050
     WRITE(6,45) ICNTRL,NS
  45 FORMAT(I1,9H SECTION ,I4)
     LINE=0
     GO TO 293
2050 IF(IERR.EQ.0)  GO TO 2200
     WRITE(6,2100)
2100 FORMAT(39H0NO POINT CARDS FOUND - PROGRAM ABORTED   )
     STOP
2200 IERR =1
     ITAPE=1
     WRITE(6,2300)
2300 FORMAT(47H0ERROR IN INPUT - POINT CARDS NOT ON INPUT FILE   ,10X,
    1        53HPROGRAM WILL CHANGE ITAPE TO 1 AND TRY TO READ TAPE50  )
     IF ( EOF(5).EQ.0 )  WRITE(6,2400)   XI,YI,ZI
2400 FORMAT(11H0EXTRA FLOW,3F12.5,5X,20HWILL NOT BE COMPUTED )
```

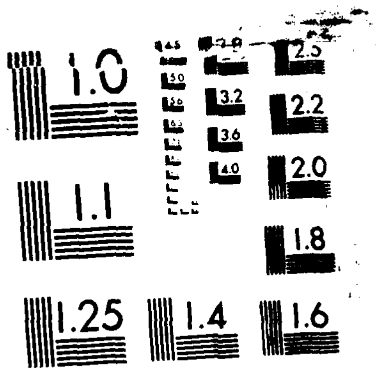
```
  292 READ(50,40) XI,YI,ZI,NI,MI,NS,NE,VN
   40 FORMAT (3F12.9,4I4,F12.9)
      EOF50=EOF(50)
      IF (EOF50.NE.0. .OR. NS.LE.0)  GO TO 2450
      WRITE(6,45) ICNTRL,NS
      LINE=0
      GO TO 293
 2450 IF (IERR.EQ.0)  GO TO 2500
      WRITE(6,2100)
      STOP
 2500 IERR=1
      ITAPE=0
      WRITE(6,2600)
 2600 FORMAT("ERROR IN INPUT - POINT CARDS NOT ON TAPE50",10X,
     1"PROGRAM WILL CHANGE ITAPE TO 0 AND TRY TO READ INPUT FILE")
      GO TO 2000
  293 VNR=VN
      NSS=NS
      PC=1
      IF (NE .EQ.0)  GO TO 2700
      MMIN=NI
      MMAX=NI
      NMIN=MI
      NMAX=MI
      GO TO 300
 2700 MMIN=MI
      MMAX=MI
      NMIN=NI
      NMAX=NI
      GO TO 300
  295 IF (ITAPE.EQ.1)  GO TO 297
      READ (5,40) XI,YI,ZI,NI,MI,NS,ME,VN
      IF (EOF(5).EQ.0.)  GO TO 299
      NS=0
      XI=0.
      YI=0.
      ZI=0.
      GO TO 299
  297 READ(50,40) XI,YI,ZI,NI,MI,NS,ME,VN
      EOF50=EOF(50)
      IF (EOF50  .NE.0)  NS=0
  299 PC=PC+1
      IF (NS.NE.NSS) GO TO 330
  300 IF (NE.EQ.0) GO TO 304
  301 IW=NI
      NI=MI
      MI=IW
C         C.  STORE PT.  IN PT. ARRAY
  304 IF (MAXPC+1-PC)  295,305,310
  305 WRITE(6,306) NS,MI,NI
  306 FORMAT(60H ERROR IN INPUT -  THERE ARE TOO MANY DATA POINTS IN SEC
     1TION   ,I4,30H  -  POINTS BEGINNING WITH M =,I4,5H   N = ,I4,
     2 17H  WILL BE IGNORED   )
      LINE=LINE+1
      ID4=ID4+1
      GO TO 295
  310 X(PC)=XI
      Y(PC)=YI
      Z(PC)=ZI
      IF (MI.LE.MAXM .AND. NI.LE.MAXN)  GO TO 315
      WRITE(6,311)  MI,NI
```

```
      LINE=LINE+1
  311 FORMAT(38H ERROR IN INPUT - INVALID M,N INDICES  ,10X,
     1  14HPOINT WITH M =  ,I4,5H  N = ,I4,17H  WILL BE IGNORED  )
      ID5=ID5+1
      PC=PC-1
      GO TO 295
  315 ID(MI,NI)=PC
      MMAX=MAXO(MMAX,MI)
      MMIN=MINO(MMIN,MI)
      NMAX=MAXO(NMAX,NI)
      NMIN=MINO(NMIN,NI)
      GO TO 295
  330 IF (IEDIT1.EQ.1) GO TO 294
      IF (LINE.LT.40)  GO TO 333
      WRITE(6,42)
      LINE=0
      GO TO 294
  333 WRITE(6,41)
  294 CONTINUE
C        E.  DO LOOPS TO SWEEP PT. ARRAY
      N1=NMIN
      MM2=MMAX-MMIN
      NN2=NMAX-NMIN
      IF (  MOD(MM2,2).EQ.0 .AND. MOD(NN2,2).EQ.0)   GO TO 332
      WRITE(6,331) NSS,MMIN,MMAX,NMIN,NMAX
      LINE=LINE+1
  331 FORMAT(16HOERROR - SECTION ,I5,45H DOES NOT HAVE QUADS ARRANGED IN
     1 BLOCKS OF 4 ,9H    MMIN= ,I2,6H MMAX= ,I2,6H NMIN= ,I2 ,
     26H NMAX= ,I2)
      ID6=ID6+1
  332 MM2=MM2/2
      NN2=NN2/2
      DO 404  NN=1,NN2
      M1=MMIN
      DO 402 MM=1,MM2
      NQ=1
C        F.  HAVE 9 CORNER PTS. BEEN GIVEN
      IT=ID(M1,N1)*ID(M1+1,N1)*ID(M1+2,N1)*ID(M1,N1+1)*ID(M1+1,N1+1)*
     1   ID(M1+1,N1+2)*ID(M1,N1+2)*ID(M1+1,N1+2)*ID(M1+2,N1+2)
      IF( IT.EQ.0 )  GO TO 402
      IERR=0
      M2=M1+1
      N2=N1+1 =M1,M2
      DO 400 N=N1,N2
      GO TO (334,335,336,337) NQ
  334 P1=ID(M  ,N  )
      P2=ID(M+1,N  )
      P3=ID(M+1,N+1)
      P4=ID(M  ,N+1)
      P5=ID(M+2,N  )
      P6=ID(M+2,N+1)
      P7=ID(M+1,N+2)
      P8=ID(M  ,N+2)
      P9=P1
      IF((X(P1).NE.X(P2).OR.Y(P1).NE.Y(P2).OR.Z(P1).NE.Z(P2))  .AND.
     1   (X(P1).NE.X(P4).OR.Y(P1).NE.Y(P4).OR.Z(P1).NE.Z(P4))) GO TO 340
       P9=ID(M+2,N+2)
      GO TO 340
  335 P1=ID(M  ,N+1)
      P2=ID(M  ,N  )
      P3=ID(M+1,N  )
```

```
      P4=ID(M+1,N+1)
      P5=ID(M  ,N-1)
      P6=ID(M+1,N-1)
      P7=ID(M+2,N  )
      P8=ID(M+2,N+1)
      P9=P1
      IF((X(P1).NE.X(P2).OR.Y(P1).NE.Y(P2).OR.Z(P1).NE.Z(P2))  .AND.
     1   (X(P1).NE.X(P4).OR.Y(P1).NE.Y(P4).OR.Z(P1).NE.Z(P4))) GO TO 340
        P9=ID(M+2,N-1)
      GO TO 340
  336 P1=ID(M+1,N  )
      P2=ID(M+1,N+1)
      P3=ID(M  ,N+1)
      P4=ID(M  ,N  )
      P5=ID(M+1,N+2)
      P6=ID(M  ,N+2)
      P7=ID(M-1,N+1)
      P8=ID(M-1,N  )
      P9=P1
      IF((X(P1).NE.X(P2).OR.Y(P1).NE.Y(P2).OR.Z(P1).NE.Z(P2))  .AND.
     1   (X(P1).NE.X(P4).OR.Y(P1).NE.Y(P4).OR.Z(P1).NE.Z(P4))) GO TO 340
        P9=ID(M-1,N+2)
      GO TO 340
  337 P1=ID(M+1,N+1)
      P2=ID(M  ,N+1)
      P3=ID(M  ,N  )
      P4=ID(M+1,N  )
      P5=ID(M-1,N+1)
      P6=ID(M-1,N  )
      P7=ID(M  ,N-1)
      P8=ID(M+1,N-1)
      P9=P1
      IF((X(P1).NE.X(P2).OR.Y(P1).NE.Y(P2).OR.Z(P1).NE.Z(P2))  .AND.
     1   (X(P1).NE.X(P4).OR.Y(P1).NE.Y(P4).OR.Z(P1).NE.Z(P4))) GO TO 340
        P9=ID(M-1,N-1)
  340 IP(1)=P1
      IP(2)=P2
      IP(3)=P3
      IP(4)=P4
      IP(5)=P5
      IP(6)=P6
      IP(7)=P7
      IP(8)=P8
      IP(9)=P9
C       G2  COMPUTE NORMAL VECTOR (XN,YN,ZN)
      X1=X(P3)-X(P1)
      X2=X(P4)-X(P2)
      Y1=Y(P3)-Y(P1)
      Y2=Y(P4)-Y(P2)
      Z1=Z(P3)-Z(P1)
      Z2=Z(P4)-Z(P2)
      XN=Y2*Z1-Y1*Z2
      YN=X1*Z2-X2*Z1
      ZN=X2*Y1-X1*Y2
      R=SQ2(XN,YN,ZN)
      IF (R.GT. .00000000001)  GO TO 345
      WRITE(6,343)
  343 FORMAT(33H ERROR IN INPUT - ZERO AREA QUAD  )
      LINE=LINE+1
      ID1=ID1+1
      AQ=0.
```

AD-A168 167 FORMULATION OF NUMERICAL METHODS USED IN THE XYZ THREE-DIMENSIONAL POTENT..(U) TEXAS A AND M UNIV COLLEGE STATION COLL OF ENGINEERING W J BEARY MAY 86 2/3

UNCLASSIFIED N00228-85-G-3303 F/G 20/4 NL



MICROCOPY RESOLUTION TEST CHART

```
      XC=0.
      YC=0.
      ZC=0.
      FL=0.
      CZ(1)=0.
      CZ(4)=0.
      CZ(5)=0.
      CZ(6)=0.
      IERR=1
      GO TO 351
  345 CONTINUE
      XN=XN/R
      YN=YN/R
      ZN=ZN/R
      A0=.5*R
C       COMPUTE CENTROID
      X1=X(P3)-X(P2)
      Y1=Y(P3)-Y(P2)
      Z1=Z(P3)-Z(P2)
      X5=Y1*Z2-Y2*Z1
      Y5=Z1*X2-Z2*X1
      Z5=X1*Y2-X2*Y1
      A1=SQ2(X5,Y5,Z5)
      A2=R-A1
      IT=1
      XC=(X(P2)+X(P4)+(A1*X(P3)+A2*X(P1))/R)/3.
      YC=(Y(P2)+Y(P4)+(A1*Y(P3)+A2*Y(P1))/R)/3.
      ZC=(Z(P2)+Z(P4)+(A1*Z(P3)+A2*Z(P1))/R)/3.
C       COMPUTE SECOND AND THIRD VECTORS
  945 X4=YN*Z1-Y1*ZN
      Y4=ZN*X1-Z1*XN
      Z4=XN*Y1-X1*YN
      A=1./SQ2(X4,Y4,Z4)
      X4=X4*A
      Y4=Y4*A
      Z4=Z4*A
      X3=ZN*Y4-Z4*YN
      Y3=XN*Z4-X4*ZN
      Z3=YN*X4-Y4*XN
C       COMPUTE POINTS IN QUAD SYSTEM
      DO 947 I=1,9
      L=IP(I)
      XP(I)=X3*(X(L)-XC)+Y3*(Y(L)-YC)+Z3*(Z(L)-ZC)
      YP(I)=X4*(X(L)-XC)+Y4*(Y(L)-YC)+Z4*(Z(L)-ZC)
  947 ZP(I)=XN*(X(L)-XC)+YN*(Y(L)-YC)+ZN*(Z(L)-ZC)
C       COMPUTE MATRIX COEF. TO FIND SURFACE EQ.
      DO 949 I=2,9
      G(I,1)=1.
      G(I,2)=XP(I)
      G(I,3)=YP(I)
      G(I,4)=XP(I)**2
      G(I,5)=YP(I)**2
      G(I,6)=YP(I)*XP(I)
  949 F(I)=ZP(I)
      DO 953 I=1,6
      G(1,I)=G(9,I)
      G(5,I)=G(5,I)+G(6,I)
  953 G(6,I)=G(7,I)+G(8,I)
      F(1)=F(9)
      F(5)=F(5)+F(6)
      F(6)=F(7)+F(8)
```

```
C       SOLVE MATRIX EQ.  G*CZ=F  FOR CZ
      CALL MATINS(G,9,6,F,6,1,DETERM,IDM,INDEX)
      IF (IDM.EQ. 1)      GO TO (955,960) IT
      IERR=1
      WRITE(6,954)
  954 FORMAT (33H ERROR IN INPUT - SINGULAR MATRIX  )
      LINE=LINE+1
      ID2=ID2+1
      GO TO 960
  955 IT=2
C       FIND NEW NORMAL VECTOR
      XN=XN-CZ(2)*X3-CZ(3)*X4
      YN=YN-CZ(2)*Y3-CZ(3)*Y4
      ZN=ZN-CZ(2)*Z3-CZ(3)*Z4
      A=1./SQ2(XN,YN,ZN)
      XN=XN*A
      YN=YN*A
      ZN=ZN*A
      GO TO 945
C       STORE DATA
  960 B(J+1)=XP(1)
      B(J+2)=YP(1)
      B(J+3)=XP(2)
      B(J+4)=YP(2)
      B(J+5)=XP(3)
      B(J+6)=XP(4)
      B(J+7)=YP(4)
      B(J+8)=X3
      B(J+9)=Y3
      B(J+10)=Z3
      B(J+11)=X4
      B(J+12)=Y4
      B(J+13)=Z4
      B(J+14)=CZ(1)
      B(J+15)=CZ(4)
      B(J+16)=CZ(5)
      B(J+17)=CZ(6)
      IF (K .LT. 7*MAXNOE)  GO TO 965
      ID7=ID7+1
      K1=K+K1
      K=0
  965 CONTINUE
      T(K+1)=XC
      T(K+2)=YC
      T(K+3)=ZC
      T(K+4)=XN
      T(K+5)=YN
      T(K+6)=ZN
      T(K+7)=AQ
C       COMPUTE QUADRUPOLE MOMENTS
      XI1=XP(1)+XP(2)
      XI2=XP(1)+XP(4)
      XI3=XP(3)+XP(2)
      XI4=XP(3)+XP(4)
      XI5=XP(2)+XP(4)
      YI1=YP(1)+YP(2)
      YI2=YP(1)+YP(4)
      YI3=YP(3)+YP(2)
      YI4=YP(3)+YP(4)
      YI5=YP(2)+YP(4)
      R1=A1/24.
```

```
      R2=A2/24.
      R3=AQ/12.
      AXX=(XI1**2+XI2**2)*R1+(XI3**2+XI4**2)*R2+XI5**2*R3
      AXY=(XI1*YI1+XI2*YI2)*R1+(XI3*YI3+XI4*YI4)*R2+XI5*YI5*R3
      AYY=(YI1**2+YI2**2)*R1+(YI3**2+YI4**2)*R2+YI5**2*R3
C       COMPUTE SOLID ANGLE
      XX=XC-XCENTER
      YY=YC-YCENTER
      ZZ=ZC-ZCENTER
      X1=XX*X3+YY*Y3+ZZ*Z3
      Y1=XX*X4+YY*Y4+ZZ*Z4
      Z1=XX*XN+YY*YN+ZZ*ZN
      RD=1./SQ2(X1,Y1,Z1)
      RCU=RD**3
      RSV=RCU**2*RD
      SA=SA+Z1*(AQ*RCU-((AXX*(Y1**2+Z1**2-4.*X1**2)
     1      +AYY*(X1**2+Z1**2-4.*Y1**2))*1.5-15.*X1*Y1*AXY)*RSV)
      B(J+18)=AXX
      B(J+19)=AXY
      B(J+20)=AYY
C       ERROR TESTS
      D1=SQ2((XP(3)-XP(1)),(YP(3)-YP(1)),0.)
      D2=SQ2((XP(4)-XP(2)),(YP(4)-YP(2)),0.)
      FL=.5*AMAX1(D1,D2)
      CZ23=ABS( CZ(2) ) + ABS( CZ(3) )
      IF( ABS(CZ(2))+ABS(CZ(3)) .GT. FL*.001 )  GO TO 970
      IF ( ABS( CZ(1))  .LT.  FL*.3 )  GO TO 977
  970 WRITE(6,975)  CZ23
  975 FORMAT(29H QUESTIONABLE POINT -POOR FIT ,6E14.3)
      IERR=1
      LINE=LINE+1
  977 IF (YP(1)*XP(2)-YP(2)*XP(1) .GE. 0. .AND.
     1    YP(2)*XP(3)-YP(3)*XP(2) .GE. 0. .AND.
     2    YP(3)*XP(4)-YP(4)*XP(3) .GE. 0. .AND.
     3    YP(4)*XP(1)-YP(1)*XP(4) .GE. 0.)      GO TO 984
  980 WRITE(6,1000)    ( XP(I),YP(I), I=1,4)
 1000 FORMAT(41H ERROR IN INPUT - CROSSED OR CONCAVE QUAD     ,
     1      4(2F10.5,3X)  )
      IERR=1
      LINE=LINE+1
      ID3=ID3+1
  984 CRCF=SQ2((XP(2)-XP(1)),(YP(2)-YP(1)),0)+XP(3)-XP(2)+ SQ2((XP(1)-
     1     XP(4)),(YP(1)-YP(4)),0.)+SQ2((XP(4)-XP(3)),(YP(4)-YP(3)),0.)
      IF ( 36.*AQ .GT. CRCF**2 )  GO TO 986
      LINE=LINE+1
      WRITE(6,961)
  961 FORMAT (24H WARNING LONG THIN QUAD.)
  986 IF ( Z1 .GE. 0. )  GO TO 351
  350 WRITE (6,85)
   85 FORMAT (35H QUESTIONABLE POINT - INWARD NORMAL)
      IERR=1
      LINE=LINE+1
C       J.  EDITE QUAD INFORMATION
  351 IF (IEDIT1.EQ.2.AND. IERR.EQ.0)  GO TO 354
      IF ( IEDIT1 .EQ. 1 )  GO TO 354
      GO TO (356,357,358,359)  NQ
  356 WRITE(6,51)  M,X(P1),X(P2),X(P3),X(P4),XC,XN,AQ    ,CZ(4)   ,
     1             N,Y(P1),Y(P2),Y(P3),Y(P4),YC,YN,FL    ,CZ(5)   ,
     2             P,Z(P1),Z(P2),Z(P3),Z(P4),ZC,ZN,CZ(1),CZ(6)
      GO TO 360
  357 WRITE(6,51)  M,X(P2),X(P3),X(P4),X(P1),XC,XN,AQ    ,CZ(4)   ,
```

```
     1                 N,Y(P2),Y(P3),Y(P4),Y(P1),YC,YN,FL    ,CZ(5)  ,
     2                 P,Z(P2),Z(P3),Z(P4),Z(P1),ZC,ZN,CZ(1),CZ(6)
      GO TO 360
  358 WRITE(6,51)  M,X(P4),X(P1),X(P2),X(P3),XC,XN,AQ    ,CZ(4)  ,
     1             N,Y(P4),Y(P1),Y(P2),Y(P3),YC,YN,FL    ,CZ(5)  ,
     2             P,Z(P4),Z(P1),Z(P2),Z(P3),ZC,ZN,CZ(1),CZ(6)
      GO TO 360
  359 WRITE(6,51)  M,X(P3),X(P4),X(P1),X(P2),XC,XN,AQ    ,CZ(4)  ,
     1             N,Y(P3),Y(P4),Y(P1),Y(P2),YC,YN,FL    ,CZ(5)  ,
     2             P,Z(P3),Z(P4),Z(P1),Z(P2),ZC,ZN,CZ(1),CZ(6)
  360 CONTINUE
   51 FORMAT (1H ,I3,8E14.5/1X,I3,8E14.5/1X,I3,8E14.5/)
      LINE=LINE+4
      IF (LINE.LT.50) GO TO 354
  352 WRITE (6,42)
      LINE=0
  354 CONTINUE
      J=J+20
      I=P
      DM(I)=UNR
      P=P+1
      NQ=NQ+1
      IERR=0
  349 K=K+7
C        K.  WRITE OUT BLOCK OF B ARRAY IF FULL
      IF (J.LT.240) GO TO 400
  355 WRITE (04) Q,(B(I),I=1,240)
      Q=P
      J=0
C        L.  END OF DO LOOP OVER PT. ARRAY
  400 CONTINUE
  402 M1=M1+2
  404 N1=N1+2
C        M.  SET FOR NEXT SECTION
      NSS=NS
      DO 405 M=MMIN,MMAX
      DO 405 N=NMIN,NMAX
  405 ID(M,N)=0
      PC=1
      IF (ME .EQ.0)  GO TO 410
      MMAX=NI
      MMIN=NI
      NMIN=MI
      NMAX=MI
      GO TO 420
  410 MMAX=MI
      MMIN=MI
      NMIN=NI
      NMAX=NI
  420 NE=ME
      UNR=UN
      IF (NS.LE.0)  GO TO 500
      WRITE(6,45) ICNTRL,NS
      LINE=0
      GO TO 300
  500 WRITE (04)  Q,(B(I),I=1,240)
  550 NP=(K+K1)/7
      ISMP = ISM + 1
      GO TO (595,590,580,570),ISMP
  570 SA=SA+SA
  580 SA=SA+SA
```

```
  590 SA=SA+SA
C       01  WRITE PARAMETERS AND T ARRAY ON TAPE
  595 J = 1
      IF (ITAPE.EQ.1 .AND. EOF50  .NE.0 )      GO TO 601
  597 WS(J) = XI
      WS(J+20) = YI
      WS(J+40) = ZI
      J = J+1
      IF(XI**2 + YI**2 + ZI**2) 599,599,598
  598 WRITE(6,600)   XI,YI,ZI
  600 FORMAT(11HOEXTRA FLOW,10X,3F12.5)
  601 READ(5,40)  XI,YI,ZI
      IF (EOF(5) .EQ. 0)  GO TO 597
      XI=0.
      YI=0.
      ZI=0.
      GO TO 597
  599 IF (ISP.LT.0) GO TO 605
      WRITE (03) (PROB(I),I=1,15)
      WRITE (03) (WS(I),I=1,220),IEDIT3,IEDIT4
      WRITE (03) (T(I),I=1,K)
      WRITE (03) (DM(I),I=1,NP)
  605 CONTINUE
C       N1  CHECK SOLID ANGLE
  610 WRITE (6,80) SA
   80 FORMAT(14HOSOLID ANGLE = ,F8.3)
  620 REWIND 04
      REWIND 03
  622 IDS=ID1+ID2+ID3+ID4+ID5+ID6+ID7
      IF (IDS.EQ.0 .AND. NP.EQ.NQE)  GO TO 638
      WRITE(6,625)
      IF (ID1 .GT.0)  WRITE(6,628)  ID1
      IF (ID2 .GT.0)  WRITE(6,629)  ID2
      IF (ID3 .GT.0)  WRITE(6,630)  ID3
      IF (ID4 .GT. 0)  WRITE(6,631)  ID4
      IF (ID5 .GT. 0)  WRITE(6,632)  ID5
      IF (ID6 .GT. 0)  WRITE(6,633)  ID6
      IF (ID7 .GT. 0)  WRITE(6,634)  NP,MAXNQE
      IF (NP.NE.NQE)  WRITE(6,637) NP,NQE
      STOP
  625 FORMAT(38HOFATAL ERROR IN DATA - PROGRAM ABORTED)
  628 FORMAT(1H0,I5,31H  QUADRILATERALS WITH ZERO AREA          )
  629 FORMAT(1H0,I5,44H  QUADRILATERALS GENERATE A SINGULAR MATRIX      )
  630 FORMAT(1H0,I5,26H  CROSSED QUADRILATERALS        )
  631 FORMAT(1H0,I5,32H  SECTIONS HAVE TOO MANY POINTS  )
  632 FORMAT(1H0,I5,34H  POINTS HAVE INVALID M,N INDICES  )
  633 FORMAT(1H0,I5,52H  SECTIONS DO NOT HAVE QUADS ARRANGED IN GROUPS O
     1F 4    )
  634 FORMAT(1H0,I5,48H  QUADRILATERALS GIVEN, EXCEEDING THE LIMIT OF  ,
     1   I4)
  637 FORMAT(1H0,I5,28H  QUADRILATERALS GIVEN, NOT  ,I4)
  638 IF (ISP.LE.0)  GO TO 640
      WRITE(6,639) ISP
  639 FORMAT(7H0   ISP=  ,I4,19H - PROGRAM ABORTED   )
      STOP
  640 CONTINUE
C       02  READ PEPS2 AND TRANSFER TO IT
      STOP 1
      END
C
      FUNCTION SQ2(X,Y,Z)
```

```
C  COMPUTE SQUAR ROOT OF R**2
      R= ABS(X)+ABS(Y)  +ABS(Z) +.000000000001
  700 RS=X**2+Y**2 +Z**2
      R=R+RS/R
      R=.25*R+RS/R
      R=R+RS/R
      SQ2=.25*R+RS/R
      RETURN
      END
C
      SUBROUTINE MATINS(A,NR,N1,B,NC,M1,DETERM,ID,INDEX)
C        MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF SIMUL. EQ.
C     PIVOT METHOD
C     FORTRAN IV SINGLE PRECISION WITH ADJUSTABLE DIMENSION
C     NOVEMBER 1971  S GOOD  NAVAL SHIP R & D CENTER
C     WHERE CALLING PROGRAM MUST INCLUDE
C                  DIMENSION  A(NR,NR), B(NR,NC), INDEX(NR,3)
C                  WHERE NR,NC ARE DIMENSIONS OF A,B,INDEX
C                  N1 IS THE ORDER OF A
C                  M1 IS THE NUMBER OF COLUMN VECTORS IN B (MAY BE 0)
C                  DETERM WILL CONTAIN DETERMINANT ON EXIT
C                  ID WILL BE SET BY ROUTINE TO 2 IF MATRIX A IS
C                  SINGULAR, 1 IF INVERSION WAS SUCCESSFUL
C                  MATRIX A (INPUT MATRIX) WILL BE REPLACED BY A INV
C                  MATRIX B: THE COLUMN VECTORS WILL BE REPLACED
C                       BY CORRESPONDING SOLUTION VECTORS
C                  INDEX: WORKING STORAGE ARRAY
C     IF IT IS DESIRED TO SCALE, THE DETERMINANT CARD 29 MAY BE
C     DELETED AND DETERM PRESET BEFORE ENTERING THE ROUTINE
C
      DIMENSION  A(NR,NR),  B(NR,NC),  INDEX(NR,3)
      EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)
C
C     INITIALIZATION
C
      N=N1
      M=M1
      DETERM=1.0
      DO 20 J=1,N
C
   20 INDEX(J,3)=0
      DO 550 I=1,N
C
C     SEARCH FOR PIVOT ELEMENT
C
      AMAX = 0.0
      DO 105 J=1,N
      IF(INDEX(J,3)-1) 60, 105, 60
   60 DO 100 K=1,N
      IF(INDEX(K,3)-1) 80, 100, 715
   80 IF (     AMAX -ABS (A(J,K))) 85, 100, 100
   85 IROW = J
      ICOLUM = K
      AMAX = ABS (A(J,K))
  100 CONTINUE
  105 CONTINUE
      INDEX(ICOLUM,3) = INDEX(ICOLUM,3) + 1
      INDEX(I,1) = IROW
      INDEX(I,2) = ICOLUM
C
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
```

```
C
      IF (IROW-ICOLUM) 140, 310, 140
  140 DETERM= -DETERM
      DO 200 L=1,N
      SWAP= A(IROW,L)
      A(IROW,L)=A(ICOLUM,L)
  200 A(ICOLUM,L)=SWAP
      IF(M) 310, 310, 210
  210 DO 250 L=1,M
      SWAP=B(IROW,L)
      B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  310 PIVOT = A(ICOLUM,ICOLUM)
      DETERM=DETERM*PIVOT
  330 A(ICOLUM,ICOLUM) = 1.0
      DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT
      IF (M) 380, 380, 360
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT
C
C     REDUCE NON-PIVOT ROWS
C
  380 DO 550 L1=1,N
      IF(L1-ICOLUM) 400, 550, 400
  400 T=A(L1,ICOLUM)
      A(L1,ICOLUM)=0.0
      DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
      IF (M) 550, 550, 460
  460 DO 500 L=1,M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
C
C     INTERCHANGE COLUMNS
C
      DO 710 I=1,N
      L=N+1-I
      IF (INDEX(L,1)-INDEX(L,2)) 630, 710, 630
  630 JROW= INDEX(L,1)
      JCOLUM=INDEX(L,2)
      DO 705 K=1,N
      SWAP = A(K,JROW)
      A(K,JROW)=A(K,JCOLUM)
      A(K,JCOLUM)=SWAP
  705 CONTINUE
  710 CONTINUE
      DO 730 K=1,N
      IF(INDEX(K,3)-1) 715, 720, 715
  720 CONTINUE
  730 CONTINUE
      ID=1
  810 RETURN
  715 ID=2
      GO TO 810
      END
/
```

APPENDIX II - XYZPF SECTION PF2

```
      PROGRAM PF2(OUTPUT=128,TAPE6=OUTPUT,TAPE03,TAPE02,TAPE08,
     1              TAPE09,TAPE01,TAPE11,TAPE04,TAPE4=TAPE04,
     3              TAPE1=TAPE01,
     2              TAPE3=TAPE03,TAPE2=TAPE02,TAPE8=TAPE08,TAPE9=TAPE09)
C
C     XYZ POTENTIAL FLOW PROGRAM  VERSION 4  SECTION 2
C     COMPUTES MATRIX COEFFICIENTS
C
      COMMON    B(241),T(4600),V1(1000),V2(1000),V3(1000),C1( 900),C2( 9
     200),C3( 900),          WS(300),PROB(15),
     3VX(8),VY(8),VZ(8)
      EQUIVALENCE(Y3,Y2)       ,(WS(201),NP),(WS(210),SYM),(WS(211),KM)
     1    ,(WS(212),IPF)   ,(WS(208),IPS) ,(KM,MK)
      INTEGER SYM
      BLK=1.0
      IDW=0
      READ(03)     (PROB(I),I=1,15)
      WRITE(6,5)
    5 FORMAT(49H0XYZ POTENTIAL FLOW PROGRAM SECTION 2, VERSION 4   )
   90 FORMAT(1H0,15A4)
      WRITE (6 ,90)           (PROB(I),I=1,15)
C       A.  READ PARAMETERS, T ARRAY, FIRST BLOCK OF B ARRAY
      READ(03)    (WS(I),I=1,220)
      READ(03)    (T(I),I=1,MK)
      READ(04)    (B(I),I=1,241)
C       B.  START LOOP OVER QUADRALATERALS
      K=1
      J=1
      P=1
      JC=1
      JU=2
      NPN=5*((NP+4)/5)
      KMM=7*NPN+1
  290 IF(B(1)-P)595,295,595
   98 FORMAT("POINTS OUT OF ORDER  B(1)=",1F4.0," P=",1F4.0)
  295 J=2
  296 X1=B(J)
      Y1=B(J+1)
      X2=B(J+2)
      Y2=B(J+3)
      X3=B(J+4)
C     Y3=Y2
      X4=B(J+5)
      Y4=B(J+6)
      XN=T(K+3)
      YN=T(K+4)
      ZN=T(K+5)
      XC=T(K)
      YC=T(K+1)
      ZC=T(K+2)
      A=T(K+6)
      XX=B(J+7)
      YX=B(J+8)
      ZX=B(J+9)
      XY=B(J+10)
      YY=B(J+11)
      ZY=B(J+12)
C       C1  COMPUTE LENGTH OF SIDES OF QUAD
      D12=SQ2F(X1,X2,Y1,Y2,0.,0.)
      D23=SQ2F(X2,X3,Y2,Y3,.0,.0)
```

```
      D34=SQ2F(X3,X4,Y3,Y4,.0,.0)
      D41=SQ2F(X4,X1,Y4,Y1,.0,.0)
C        C2  COMPUTE SLOPE OF SIDES
      IF(X2-X3)305,300,305
  300 CI23=1.
      GO TO 310
  305 CM23=(Y2-Y3)/(X2-X3)
      CI23=0.
  310 IF(X3-X4)315,311,315
  311 CI34=1.
      GO TO 320
  315 CM34=(Y4-Y3)/(X4-X3)
      CI34=0.
  320 IF(X4-X1)325,321,325
  321 CI41=1.
      GO TO 330
  325 CM41=(Y1-Y4)/(X1-X4)
      CI41=0.
  330 IF(X1-X2)335,331,335
  331 CI12=1.
      GO TO 340
  335 CM12=(Y2-Y1)/(X2-X1)
      CI12=0.
C        C3  COMPUTE QUADRAPOLE MOMENTS
  340 CIXX=B(J+17)
      CIXY=B(J+18)
      CIYY=B(J+19)
      CY12=0.0
      CX12=0.0
      CY23=0.0
      CX23=0.0
      CY34=0.0
      CX34=0.0
      CY41=0.0
      CX41=0.0
C        C4  COMPUTE SIN AND COS OF SLOPE ANGLE FOR EACH SIDE
      IF (D12) 9341,9342,9341
 9341 CY12=(Y2-Y1)/D12
      CX12=(X1-X2)/D12
 9342 IF(D23)9343,9344,9343
 9343 CY23=(Y3-Y2)/D23
      CX23=(X2-X3)/D23
 9344 IF(D34)9345,9346,9345
 9345 CY34=(Y4-Y3)/D34
      CX34=(X3-X4)/D34
 9346 IF(D41)9347,9348,9347
 9347 CY41=(Y1-Y4)/D41
      CX41=(X4-X1)/D41
C        C5  COMPUTE MAX LENGTH OF QUAD
 9348 ST=ABS(X1-X3)
      ST2=SQ2F(X2,X4,Y2,Y4,.0,.0)
      ST=AMAX1(ST,ST2,D12,D23,D34,D41)
C        D.  START LOOP OVER NULL PTS
  342 KQ=1
      L=1
  343 I=KQ
      IF(IPS) 9360,9360,9350
 9350 IF(L-IPS) 9355,9352,9352
 9352 IF(L-IPF) 9360,9360,9355
 9355 C1(JC)=.0
      C2(JC)=.0
      C3(JC)=.0
```

```
      GO TO 541
 9360 IS=1
      XCQ=T(I)
      YCQ=T(I+1)
      ZCQ=T(I+2)
      XNQ=T(I+3)
      YNQ=T(I+4)
  344 ZNQ=T(I+5)
C       E.  COMPUTE DISTANCE BETWEEN QUAD AND NULL PT.
C            . DETERMIN METHOD
  345 RPQ=SQ2F(XC,XCQ,YC,YCQ,ZC,ZCQ)
      IF(RPQ-ST*4)350,350,460
  350 X=(XCQ-XC)*XX+(YCQ-YC)*YX+(ZCQ-ZC)*ZX
      Y=(XCQ-XC)*XY+(YCQ-YC)*YY+(ZCQ-ZC)*ZY
      Z=(XCQ-XC)*XN+(YCQ-YC)*YN+(ZCQ-ZC)*ZN
      IF(RPQ-ST*2.0)355 355,400
C       F.  COMPUTE VELOCITY COEF. BY EXACT METHOD
  355 R1=SQ2F(X,X1,Y,Y1,Z,0.)
      R2=SQ2F(X,X2,Y,Y2,Z,0.)
      R3=SQ2F(X,X3,Y,Y3,Z,0.)
      R4=SQ2F(X,X4,Y,Y4,Z,0.)
      IF ((R1+R2) .LE. D12)  GO TO  1000
      IF ((R2+R3) .LE. D23)  GO TO  1000
      IF ((R3+R4) .LE. D34)  GO TO  1000
      IF ((R4+R1) .LE. D41)  GO TO  1000
      CLA1=ALOG((R1+R2-D12)/(R1+R2+D12))
      CLA2=ALOG((R2+R3-D23)/(R2+R3+D23))
      CLA3=ALOG((R3+R4-D34)/(R3+R4+D34))
      CLA4=ALOG((R4+R1-D41)/(R4+R1+D41))
      TVX=CY12*CLA1+CY23*CLA2+CY34*CLA3+CY41*CLA4
      TVY=CX12*CLA1+CX23*CLA2+CX34*CLA3+CX41*CLA4
      TVZ=0.
      IF(ABS(Z/ST)-.010)  375,361,361
  361 ZSQ=Z**2
      E1=ZSQ+(X-X1)**2
      E2=ZSQ+(X-X2)**2
      E3=ZSQ+(X-X3)**2
      E4=ZSQ+(X-X4)**2
      H1=(Y-Y1)*(X-X1)
      H2=(Y-Y2)*(X-X2)
      H3=(Y-Y3)*(X-X3)
      H4=(Y-Y4)*(X-X4)
      IF(CI12)363,363,364
  363 WS1=(CM12*E1-H1)/(Z*R1)
      WS2=(CM12*E2-H2)/(Z*R2)
      AT1=ATAN(WS1)
      AT2=ATAN(WS2)
      TVZ=AT1-AT2
  364 IF(CI23)366,366,367
  366 AT3=ATAN((CM23*E2-H2)/(Z*R2))
      AT4=ATAN((CM23*E3-H3)/(Z*R3))
      TVZ=TVZ+AT3-AT4
  367 IF(CI34)368,368,369
  368 AT5=ATAN((CM34*E3-H3)/(Z*R3))
      AT6=ATAN((CM34*E4-H4)/(Z*R4))
      TVZ=TVZ+AT5-AT6
  369 IF(CI41)370,370,375
  370 AT7=ATAN((CM41*E4-H4)/(Z*R4))
      AT8=ATAN((CM41*E1-H1)/(Z*R1))
      TVZ=TVZ+AT7-AT8
  375 GO TO 450
C       G.  COMPUTE VELOCITY COEF. BY QUADRAPOLE METHOD
```

```
  400 RPQ3=RPQ**3
      RPQ7=(RPQ3**2)*RPQ
      WS1= X/RPQ3
      XSQ=X**2
      YSQ=Y**2
      ZSQ=Z**2
      PS=YSQ+ZSQ-4.*XSQ
      QS=XSQ+ZSQ-4.*YSQ
      WS2=X*(9.*PS+30.*XSQ)/RPQ7
      WS3=3.*Y*PS/RPQ7
      WS4=3.*X*QS/RPQ7
      TVX=A*WS1-CIXY*WS3-CIXX*WS2-CIYY*WS4
      WS1=Y/RPQ3
      WS2=Y*(9.*QS+30.*YSQ)/RPQ7
      TVY=A*WS1-CIXX*WS3-CIXY*WS4-CIYY*WS2
      TVZ=Z*(A/RPQ3-3.*(CIXX*PS-5.*CIXY*X*Y+CIYY*QS)/RPQ7)
  450 VX(IS)=TVX*XX+TVY*XY+TVZ *XN
      VY(IS)=TVX*YX+TVY*YY+TVZ*YN
      VZ(IS)=TVX*ZX+TVY*ZY+TVZ*ZN
      GO TO 470
C       H.  COMPUTE VELOCITY COEF. BY MONOPOLE METHOD
  460 ARPQ3=A/(RPQ**3)
      VX(IS)=  (XCQ-XC)*ARPQ3
      VY(IS)=  (YCQ-YC)*ARPQ3
      VZ(IS)=  (ZCQ-ZC)*ARPQ3
C       I.  REFLECT NULL PT. IN PLANE OF SYMETRY
  470 GO TO(480,485,490,495,500,505,510,515),IS
C           DO LOOPS SET UP TO FORCE USE OF INDEX REGISTERS
  480 J1=JV
      J2=JC
      VDX=VX(1)
      VDY=VY(1)
      VDZ=VZ(1)
      V1(J1)=VX(1)
      V2(J1)=VX(1)
      V3(J1)=VX(1)
      V1(J1+1)=VY(1)
      V2(J1+1)=VY(1)
      V3(J1+1)=VY(1)
      V1(J1+2)=VZ(1)
      V2(J1+2)=VZ(1)
      V3(J1+2)=VZ(1)
      IF(SYM) 530,530,481
  481 IS=2
C              XZ SYMETRY
      YCQ=-YCQ
      GO TO 345
  485 IF(SYM-1)517,517,486
C              XY SYMETRY
  486 IS=3
      ZCQ=-ZCQ
      GO TO 345
  490 IS=4
      YCQ=-YCQ
      GO TO 345
  495 IF(SYM-2)516,516,496
C              YZ SYMETRY
  496 IS=5
      XCQ=-XCQ
      GO TO 345
  500 IS=6
      YCQ=-YCQ
```

```
      GO TO 345
  505 IS=7
      ZCQ=-ZCQ
      GO TO 345
  510 IS=8
      YCQ=-YCQ
      GO TO 345
C        J.  ADD CONTRIBUTIONS OF ALL REFLECTIONS
  515 V1(J1)=V1(J1)+UX(8)+UX(7)+UX(6)+UX(5)
      V2(J1)=V2(J1)-UX(8)+UX(7)+UX(6)-UX(5)
      V3(J1)=V3(J1)-UX(8)-UX(7)+UX(6)+UX(5)
      V1(J1+1)=V1(J1+1)-UY(8)+UY(7)+UY(6)-UY(5)
      V2(J1+1)=V2(J1+1)+UY(8)+UY(7)+UY(6)+UY(5)
      V3(J1+1)=V3(J1+1)+UY(8)-UY(7)+UY(6)-UY(5)
      V1(J1+2)=V1(J1+2)-UZ(8)-UZ(7)+UZ(6)+UZ(5)
      V2(J1+2)=V2(J1+2)+UZ(8)-UZ(7)+UZ(6)-UZ(5)
      V3(J1+2)=V3(J1+2)+UZ(8)+UZ(7)+UZ(6)+UZ(5)
  516 V1(J1)=V1(J1)+UX(4)+UX(3)
      V2(J1)=V2(J1)+UX(4)-UX(3)
      V3(J1)=V3(J1)-UX(4)-UX(3)
      V1(J1+1)=V1(J1+1)+UY(4)-UY(3)
      V2(J1+1)=V2(J1+1)+UY(4)+UY(3)
      V3(J1+1)=V3(J1+1)-UY(4)+UY(3)
      V1(J1+2)=V1(J1+2)-UZ(4)-UZ(3)
      V2(J1+2)=V2(J1+2)-UZ(4)+UZ(3)
      V3(J1+2)=V3(J1+2)+UZ(4)+UZ(3)
  517 V1(J1)=V1(J1)+UX(2)
      V2(J1)=V2(J1)-UX(2)
      V3(J1)=V3(J1)+UX(2)
      V1(J1+1)=V1(J1+1)-UY(2)
      V2(J1+1)=V2(J1+1)+UY(2)
      V3(J1+1)=V3(J1+1)-UY(2)
      V1(J1+2)=V1(J1+2)+UZ(2)
      V2(J1+2)=V2(J1+2)-UZ(2)
      V3(J1+2)=V3(J1+2)+UZ(2)
  530   C1(J2)=XNQ*V1(J1)+YNQ*V1(J1+1)+ZNQ*V1(J1+2)
        C2(J2)=XNQ*V2(J1)+YNQ*V2(J1+1)+ZNQ*V2(J1+2)
        C3(J2)=XNQ*V3(J1)+YNQ*V3(J1+1)+ZNQ*V3(J1+2)
  540 JV=JV+3
  541 JC=JC+1
C        D.  WRITE COEFICIENTS
C        K.  WRITE COEF. ON TAPE OR DRUM IF STORAGE AREA IS FULL
  545 IF(JV-1001)570,555,555
  555 JV=2
      V1(1)=BLK
      V2(1)=BLK
      V3(1)=BLK
      IF(BLK-636.0) 560,563,566
  560 WRITE (01) BLK,V1,V2,V3
      GO TO 568
  563 REWIND 01
  566 WRITE(11) BLK,V1,V2,V3
  568 BLK=BLK+1.
  570 IF(JC-901)580,571,571
  571 IDW=IDW+1
      WRITE (02) IDW,C1
      WRITE (08) IDW,C2
      WRITE (09) IDW,C3
  576 JC=1
  580 KO=KO+7
      L=L+1
C        L   END OF LOOP OVER NULL PTS.
```

```
      IF(KQ-KM  )343,343,581
  581 C1(JC)=0
      C2(JC)=0
      C3(JC)=0
      IF(KQ-KMM)541,585,585
  585 P=P+1
      K=K+7
      J=J+20
      IF(K-KM  )596,586,600
C       N.  END OF LOOP OVER QUADS.
C       M.  READ NEXT BLOCK OF B ARRAY IF NEEDED
  586 IF(J-241)296,590,590
  590 READ(04)(B(I),I=1,241)
      J=2
      IF(B(1)-P)595,296,595
  595 WRITE (6,98) B(1),P
      STOP
  600 IF(BLK-636.0) 610,620,630
C       O.  WRITE REMAINING COEF. ON TAPE OR DRUM
  610 WRITE(01)BLK,V1,V2,V3
      REWIND 01
      GO TO 640
  620 REWIND 01
  630 WRITE(11) BLK,V1,V2,V3
      REWIND 11
  640 WRITE (02) IDW,C1
      WRITE (08) IDW,C2
      WRITE (09) IDW,C3
      REWIND 02
      REWIND 03
      REWIND 04
      REWIND 08
      REWIND 09
C       P.  TRANSFER TO PFPS3
      GO TO 5000
 1000 WRITE(6,2000)  L,P
 2000 FORMAT(3H L= ,I5,20X,3H P= ,F5.1)
 5000 CONTINUE
      STOP 2
      END
      FUNCTION SQ2F(X1,X2,Y1,Y2,Z1,Z2)
      X=X1-X2
      Y=Y1-Y2
      Z=Z1-Z2
      RS=Z**2+Y**2+X**2
      R=ABS(X)+ABS(Y)+ABS(Z)+ 1.0E-20
      R=R+RS/R
      R=.25*R+RS/R
      R= R+RS/R
      SQ2F= .25*R+RS/R
      RETURN
      END
```

APPENDIX III - XYZPF SECTION PF3

```
      PROGRAM PFP3(OUTPUT=128,TAPE02,TAPE08,TAPE09,
     1             TAPE12,TAPE03,TAPE6=OUTPUT,TAPE2=TAPE02,
     2             TAPE8=TAPE08,TAPE9=TAPE09,TAPE3=TAPE03)
C
C     XYZ POTENTIAL FLOW PROGRAM  VERSION 1  SECTION 3
C     SOLVES MATRIX EQUATION FOR SOURCE DENSITY
C
      COMMON    SN(654),VIP(650),S(5,650),PROB(15),WS(220),DM(650),
     1          B(220),COEF(900),XN(650),YN(650),ZN(650)
      EQUIVALENCE (WS(213),EPS) ,(KK,B(201))
      EQUIVALENCE (MIX,WS(205)),(MIY,WS(206)),(MIZ,WS(207))
      EQUIVALENCE (WS(201),NP),(WS(208),IPS),(WS(212),IPF),(WS(211),KM),
     1(KM,MK)
    5 FORMAT(49H1XYZ POTENTIAL FLOW PROGRAM SECTION 3, VERSION 4   )
      WRITE (6,5)
      READ     (03)(PROB(I),I=1,15)
      WRITE             ( 6,1001)(PROB(I),I=1,15)
 1001 FORMAT(1H0,15A4)
      READ (03) (WS(I),I=1,220),IEDIT3,IEDIT4
      READ     (03)(SKIP,SKIP,SKIP,XN(I),YN(I),ZN(I),SKIP,I=1,NP)
      D=-.5/3.14159265
      READ     (03)(DM(I),I=1,NP)
      K1=1
      K2=NP
  240 FORMAT (18HOCHANGES IN PROB -,15A4)
      IF(IPS)1220,1220,1231
 1231 READ     (12)( B(K),K=1,15)
      WRITE             ( 6,240)(B(K),K=1,15)
      READ     (12)( B(K),K=1,220)
      READ     (12)SKIP
      READ     (12)SKIP
      K1=IPS
      K2=IPF
C       A.  SET CONDITIONS FOR FLOW OF -1 IN X DIRECTION
 1220 FX=-1
      FY=0
      FZ=0
      NF=-1
C       B.  COMPUTE INITIAL APPROXIMATION TO THE SOURCE
 1240 DO 1250 K=1,NP
      VIP(K)=XN(K)*FX+YN(K)*FY+ZN(K)*FZ-DM(K)
      S(5,K)=-VIP(K)*.11936
C       C.  SET PARTIAL SUM VECTOR TO ZERO
 1250 SN(K)=0.
      SN(NP+1)=0.
      SN(NP+2)=0.
      SN(NP+3)=0.
      SN(NP+4)=0.
      WRITE(6,997) FX,FY,FZ
      WRITE (6,998)
  998 FORMAT(27H0ITERATION   SUM OF CHANGES ,9X,1HA,10X,2HB1,10X,2HB2)
      IT=1
      IC=5
      IF (IPS) 1260,1260,1255
 1255 READ(12)  (S(5,K), K=1,KK)
      DO 1256 K=1,KK
      DO 1256 I=1,4
 1256 S(I,K)=S(5,K)
C       D. START ITERATION
 1260 BAND=0
```

```
      IF (NF)1261,1262,1263
 1261 READ (02)IDW,COEF
      GO TO 1264
 1262 READ (08)IDW,COEF
      GO TO 1264
 1263 READ (09)IDW,COEF
 1264 J=0
C        D.  READ FIRST BLOCK OF COEF
C        E.  START LOOP OVER QUADS.
      DO 1290 K=1,NP
C        F.  PICK UP SOURCE DENSITY
      SP=S(IC,K)
C        G.  START LOOP OVER NULL PTS.
      DO 1290 KP=1,NP,5
      IF(J-900)80,65,65
   65 IF (NF)67,68,69
   67 READ (02)IDW,COEF
      GO TO 70
   68 READ (08)IDW,COEF
      GO TO 70
   69 READ (09)IDW,COEF
   70 J=0
C        H.  COMPUTE PARTIAL SUM FOR NEXT 5 PTS.
   80 SN(KP)=SN(KP)+COEF(J+1)*SP
      SN(KP+1)=SN(KP+1)+COEF(J+2)*SP
      SN(KP+2)=SN(KP+2)+COEF(J+3)*SP
      SN(KP+3)=SN(KP+3)+COEF(J+4)*SP
      SN(KP+4)=SN(KP+4)+COEF(J+5)*SP
      J=J+5
C        J.  END OF LOOP OVER NULL PTS.
C        K.  END OF LOOP OVER QUADS.
 1290 CONTINUE
C        L.  COMPUTE NEW SOURCE
      IF (NF) 91,92,93
   91 REWIND 02
      GO TO 94
   92 REWIND 08
      GO TO 94
   93 REWIND 09
   94 PASS=1.0
      SUM=0.
      DO 100 K=K1,K2
      SN(K)=( SN(K)+VIP(K) )*D
      TEST=ABS(SN(K)-S(IC,K))
      SUM=SUM+TEST
      IF (TEST .GT. EPS)  PASS=-1.0
  100 CONTINUE
      IF (PASS .EQ. 1.0)  GO TO 180
      IF (IT.GE.MIX)  GO TO 180
      IF (IEDIT3 .EQ. 0) WRITE(6,99) IT,SUM
      IT=IT+1
      IC=IC-1
      IF (IC .EQ. 0)  GO TO 120
      DO 110 K=K1,K2
      S(IC,K)=SN(K)
  110 SN(K)=0.
      GO TO 1260
  120 A=0.
      B1=0.
      B2=0.
      DA=0.
      D1=0.
```

```
      D2=0.
      DO 140 K= K1,K2
      DS9=2*S(1,K)-SN(K)-S(2,K)
      IF(DS9 .GT. 0.)  GO TO 122
      A=A+S(2,K)-S(1,K)
      DA=DA-DS9
      GO TO 125
  122 A =A +S(1,K)-S(2,K)
      DA=DA+DS9
  125 DS1=S(4,K)-S(3,K)
      DS2=S(3,K)-S(2,K)
      DS3=DS1-DS2
      DSS=S(2,K)-S(1,K)
      DS5=DS2-DSS
      DS6=DS1-DSS
      DS4=DS2-S(1,K)+SN(K)
      DS7=DS3*DS4-DS5*DS6
      DS8=DS6*DS5-DS4*DS3
      IF(DS7 .GT. 0.) GO TO 128
      B1=B1-DS1*DS4+DS2*DS6
      D1=D1-DS7
      GO TO 130
  128 B1=B1+DS1*DS4-DS2*DS6
      D1=D1+DS7
  130 IF (DS8 .GT. 0.)  GO TO 132
      B2=B2-DS1*DS5+DS2*DS3
      D2=D2-DS8
      GO TO 140
  132 B2=B2+DS1*DS5-DS2*DS3
      D2=D2+DS8
  140 CONTINUE
      A=A/DA
      B1=B1/D1
      B2=B2/D2
      IF(IT .EQ. 6)  GO TO 155
      AA=A-AS
      AA=ABS(AA)
      IF (AA .GT.  .02) GO TO 148
      DO 145 K=K1,K2
      S(5,K)=A*(SN(K)-S(1,K))+S(1,K)
  145 SN(K)=0.
      WRITE(6,6000)
 6000 FORMAT(29X,17HA EXTRAPOLATION     )
      GO TO 160
  148 BB1=B1-BS1
      BB1=ABS(BB1)
      BB1=50.*BB1
      BB2=B2-BS2
      BB2=ABS(BB2)
      BB2=50.*BB2
      BBB=ABS(B1) + ABS(B2)
      IF ( (BB1 .GT. BBB)  .OR.  (BB2 .GT. BBB) )  GO TO 155
      DO 150 K=K1,K2
      S(5,K)=S(2,K)+B1*(S(1,K)-S(2,K))+B2*(SN(K)-S(2,K))
  150 SN(K)=0.
      WRITE(6,7000)
 7000 FORMAT(29X,17HB EXTRAPOLATION     )
      GO TO 160
  155 DO 158 K=K1,K2
      S(5,K)=SN(K)
  158 SN(K)=0.
  160 IC=5
```

```
      WRITE(6,161)  A,    B1,     B2
  161 FORMAT(29X,3E12.3)
      AS=A
      BS1=B1
      BS2=B2
      GO TO 1260
  180 WRITE(6,99) IT,SUM
      DO 182 K=K1,K2
  182 S(1,K)=SN(K)
      WRITE(03)  (S(1,K), K=1,NP)
   99 FORMAT(4X,I3,E18.5)
  997 FORMAT (13H0 X VELOCITY=,F4.1,15H     Y VELOCITY=,F4.1,
     115H     Z VELOCITY=,F4.1)
      IF(FZ)1400,1390,1400
C        P1  IF THIS WAS NOT LAST FLOW, SET FOR NEXT FLOW
 1390 FZ=FY
      FY=FX
      FX=0
      MIX=MIY
      MIY=MIZ
      NF=NF+1
      GO TO 1240
 1400 REWIND 03
C        P2  READ IN PFPS4 AND TRANSFER TO IT
      STOP 3
      END
```

APPENDIX IV - XYZPF SECTION PF4

```
      PROGRAM PFP4(OUTPUT,TAPE6=OUTPUT,TAPE03,TAPE01,TAPE11,
     1              TAPE3=TAPE03,TAPE1=TAPE01)
C
C     XYZ POTENTIAL FLOW PROGRAM  VERSION 1  SECTION 4
C     COMPUTES VELOCITIES AND PRESSURE COEFFICIENTS FOR
C     POINTS ON THE BODY
C
      COMMON    VX1(650),VY1(650),VZ1(650),   VX2(650),VY2(650),VZ2(650)
     1         ,VX3(650),VY3(650),VZ3(650),    S1(650), S2(650), S3(650)
     2         ,  X(650),  Y(650),  Z(650),    T4(650), T5(650), T6(650)
     3         , DM(650)
      DIMENSION PROB(15),WS(220),CV1(1000),CV2(1000),CV3(1000)
      EQUIVALENCE (WS(201),NP),(WS(211),KM),(WS(217),VXI),(WS(218),VYI),
     1(WS(219),VZI),(WS(208),IPS),(WS(212),IPF)
      EQUIVALENCE (MIX,WS(205)),(MIY,WS(206)),(MIZ,WS(207))
    5 FORMAT(49H0XYZ POTENTIAL FLOW PROGRAM SECTION 4, VERSION 4   )
      WRITE (6,5)
      READ     (03)(PROB(I),I=1,15)
  100 FORMAT(1H ,15A4)
      WRITE          ( 6,100)(PROB(I),I=1,15)
C       A.  READ PARAMETERS AND SOURCE
      READ (03) (WS(I),I=1,220),IEDIT3,IEDIT4
      READ     (03)(X(I),Y(I),Z(I),T4(I),T5(I),T6(I),SKIP, I=1,NP)
      READ     (03)(DM(I),I=1,NP)
      D=-.5/3.14159265
      READ     (03)(S1(I),I=1,NP)
      READ     (03)(S2(I),I=1,NP)
      READ (03) (S3(I),I=1,NP)
      J=1
      K1=1
      K2=NP
      IF(IPS)108,108,102
  102 K1=IPS
      K2=IPF
  108 BBR=1.
C       B.  READ FIRST BLOCK OF COEF.
      ITAPE=01
      READ (01) BB,CV1,CV2,CV3
      IF (BB-BBR) 300,120,300
  120 DO 125I=K1,K2
      VX1(I)=-1.0         -S1(I)*T4(I)    /D
      VY1(I)=             -S1(I)*T5(I)    /D
      VZ1(I)=             -S1(I)*T6(I)    /D
      VX2(I)=             -S2(I)*T4(I)    /D
      VY2(I)=-1.0         -S2(I)*T5(I)    /D
      VZ2(I)=             -S2(I)*T6(I)    /D
      VX3(I)=             -S3(I)*T4(I)    /D
      VY3(I)=             -S3(I)*T5(I)    /D
  125 VZ3(I)=-1.0         -S3(I)*T6(I)    /D
C       C.  SET UP LOOP OVER QUADS.
      JC=2
C       D.  PICK UP SOURCE
  130 S1J=S1(J)
      S2J=S2(J)
      S3J=S3(J)
C       E.  SET UP LOOP OVER NULL PTS.
      DO 180 JP=K1,K2
C       F.  COMPUTE PARTIAL SUM FOR 3 COMPONENTS OF 3 VELOCITIES
      VX1(JP)=VX1(JP)+S1J*CV1(JC)
      VY1(JP)=VY1(JP)+S1J*CV1(JC+1)
```

```
      UZ1(JP)=UZ1(JP)+S1J*CU1(JC+2)
      UX2(JP)=UX2(JP)+S2J*CU2(JC)
      UY2(JP)=UY2(JP)+S2J*CU2(JC+1)
      UZ2(JP)=UZ2(JP)+S2J* CU2(JC+2)
      UX3(JP)=UX3(JP)+S3J*CU3(JC)
      UY3(JP)=UY3(JP)+S3J*CU3(JC+1)
      UZ3(JP)=UZ3(JP)+S3J*CU3(JC+2)
      JC=JC+3
C       G.  READ MORE COEF. IF NEEDED.
      IF (JC-1000)180, 135, 135
  135 JC=2
      IF(BBR-635.0) 140, 150, 155
  140 READ (01) BB,CU1,CU2,CU3
      GO TO 160
  150 REWIND 01
  155 READ (11) BB,CU1,CU2,CU3
  160 BBR=BBR+1.
      IF (BBR-BB) 300, 180,300
C       H.  END OF LOOP OVER NULL PTS.
  180 CONTINUE
      J=J+1
C       I.  END OF LOOP OVER QUADS.
      IF(J-NP)130, 130,200
  200 IF(BBR-635.0) 231,231,232
  231 REWIND 01
      GO TO 233
  232 REWIND 11
C       K.  EDIT THE VELOCITIES ETC. AND WRITE THEM ON TAPE
  233 WRITE     (03)(UX1(I),UY1(I),UZ1(I)          ,I=1,NP)
      WRITE     (03)(UX2(I),UY2(I),UZ2(I)          ,I=1,NP)
      WRITE     (03)(UX3(I),UY3(I),UZ3(I)          ,I=1,NP)
  235 FORMAT(1H1, 15A4,8H  PAGE =, I15)
      REWIND 03
      IP=K1+49
      IS=K1
      IPAGE=1
      IF (IEDIT4 .EQ. 1) GO TO 293
      IF (MIX .LE.0 )  GO TO 265
  242 FORMAT(8HO X FLOW)
  240 FORMAT(4H PT., 10X, 1HX, 9X, 1HY, 9X, 1HZ, 13X, 2HUX, 8X, 2HUY, 8X, 2HUZ, 10X,
     1 5HABS.U, 7X,2HCP, 6X, 6HSOURCE, 4X, 8HU NORMAL)
  245 FORMAT (1X, I3,4X,3F10.5,4X,3F10.5, 1F13.5,2F11.5,E12.2)
  250 IF(IP-K2)255,255,260
C       J.  COMPUTE PRESSURE AND ABS. VALUE OF VELOCITY
  255 WRITE               (6,235)(PROB(I),I=1, 15),IPAGE
      WRITE               (6,242)
      WRITE               (6,240)
      DO 257 I=IS,IP
      USQ=UX1(I)**2+UY1(I)**2+UZ1(I)**2
      UM=(ABS(UX1(I))+ABS(UY1(I))+ABS(UZ1(I)))*.79
      UM=UM+USQ/UM
      UM=.25*UM+USQ/UM
      UM    =.5*(UM+USQ/UM)
      CP    =1.-USQ
      UNR   =UX1(I)*T4(I)   +UY1(I)*T5(I)    +UZ1(I)*T6(I)
  257 WRITE (6,245)  I,X(I),Y(I),Z(I),UX1(I),UY1(I),UZ1(I),UM
     1     ,CP     ,S1(I),UNR
      IS=IS+50
      IP=IP+50
      IPAGE=IPAGE+1
      IF(K2-IS) 265,260,250
  260 IP=K2
```

```
      GO TO 255
  265 IP=K1+49
      IS=K1
      IF (MIY .LE.0 )  GO TO 280
  267 IF(IP-K2)275,275,270
  270 IP=K2
  275 WRITE              (6,235)(PROB(I),I=1,15),IPAGE
      WRITE              (6,277)
  277 FORMAT(8HO Y FLOW)
      WRITE              (6,240)
      DO 278 I=IS,IP
      VSQ=VX2(I)**2+VY2(I)**2    +VZ2(I)**2
      VM=(ABS(VX2(I))+ABS(VY2(I))+ABS(VZ2(I)))*.79
      VM=VM+VSQ/VM
      VM=.25*VM+VSQ/VM
      VM     =.5*(VM+VSQ/VM)
      VNR     =VX2(I)*T4(I)    +VY2(I)*T5(I)    +VZ2(I)*T6(I)
      CP     =1.-VSQ
  278 WRITE (6,245) I,X(I),Y(I),Z(I),VX2(I),VY2(I),VZ2(I),VM
     1     ,CP     ,S2(I),VNR
      IS=IS+50
      IP=IP+50
      IPAGE=IPAGE+1
      IF(IS-K2)267,267,280
  280 IP=K1+49
      IS=K1
      IF (MIZ .LE.0 )  GO TO 293
  282 IF(IP-K2)290,290,285
  285 IP=K2
  290 WRITE              (6,235)(PROB(I),I=1,15),IPAGE
      WRITE              (6,292)
  292 FORMAT(8HO Z FLOW)
      WRITE              (6,240)
      DO 291 I=IS,IP
      VSQ=VX3(I)**2+VY3(I)**2+VZ3(I)**2
      VM=(ABS(VX3(I))+ABS(VY3(I))+ABS(VZ3(I)))*.79
      VM=VM+VSQ/VM
      VM=.25*VM+VSQ/VM
      VM     =.5*(VM+VSQ/VM)
      CP     =1.-VSQ
      VNR     =VX3(I)*T4(I)    +VY3(I)*T5(I)    +VZ3(I)*T6(I)
  291 WRITE   (6,245) I,X(I),Y(I),Z(I),VX3(I),VY3(I),VZ3(I),VM
     1     ,CP     ,S3(I),VNR
      IS=IS+50
      IP=IP+50
      IPAGE=IPAGE+1
      IF(IS-K2)282,282,293
C       L.  CHECK FOR A FOURTH FLOW
  293 J = 1
  294 VXI = WS(J)
      VYI = WS(J+20)
      VZI = WS(J+40)
  295 IF (VXI**2+VYI**2+VZI**2) 400,400,301
  301 IS=K1
      IP=K1+49
  320 IF (IP-K2)330,325,325
C       N.  EDIT THE VELOCITY AND PRESSURE FOR FOURTH FLOW
  325 IP=K2
  330 WRITE              (6,235)(PROB(I),I=1,15),IPAGE
      WRITE              (6,315)VXI,VYI,VZI
      WRITE              (6,340)
C       M.  COMPUTE VELOCITY AND PRESSURE FOR FOURTH FLOW
```

```
      DO 333 I=IS,IP
      UX4    =- (UXI*UX1(I)+UYI*UX2(I)+UZI*UX3(I))
      UY4    =- (UXI*UY1(I)+UYI*UY2(I)+UZI*UY3(I))
      UZ4    =- (UXI*UZ1(I)+UYI*UZ2(I)+UZI*UZ3(I))
      USQ=UX4    **2+UY4    **2+UZ4    **2
      UM=(ABS(UX4    )+ABS(UY4    )+ABS(UZ4    ))*.79
      UM=UM+USQ/UM
      UM=.25*UM+USQ/UM
      UM     =.5*(UM+USQ/UM)
      CP     = 1.-(USQ)/( UYI**2+UZI**2+UXI**2)
  333 WRITE   (6,345) I,X(I),Y(I),Z(I),UX4    ,UY4    ,UZ4    ,UM
     1     ,CP
      IS=IS+50
      IP=IP+50
      IPAGE=IPAGE+1
      IF(K2-IS)350,325,320
  350 J = J+1
      GO TO 294
  315 FORMAT(19H0  ONSET FLOW, UXI=,F6.3,2X,4HUYI=,F6.3,2X,4HUZI=,F6.3)
  340 FORMAT(4H PT., 10X, 1HX,9X, 1HY,9X, 1HZ, 13X, 2HUX, 8X, 2HUY, 8X, 2HUZ, 10X,
     1 5HABS.U, 7X,2HCP)
  345 FORMAT (1X,I3,4X,3F10.5,4X,3F10.5,1F13.5,1F11.5)
  400 CONTINUE
      GO TO 5000
  300 CONTINUE
      WRITE (6,310) ITAPE,BBR,BB
  310 FORMAT (6H1TAPE ,I2,17H OUT OF POSSITION/1I4,6F6.1)
 5000 CONTINUE
      STOP 4
      END
```

APPENDIX V - XYZPF SECTION PF5

```
      PROGRAM PFP5(INPUT=128,OUTPUT=128,TAPE03,TAPE04,
     1TAPE5=INPUT,TAPE6=OUTPUT,TAPE3=TAPE03,TAPE4=TAPE04)
C
C     XYZ POTENTIAL FLOW PROGRAM  VERSION 4  SECTION 5
C     COMPUTES VELOCITIES AND PRESSURE COEFFICIENTS FOR
C     OFF BODY POINTS
C
      COMMON    B(241),        XP(500),YP(500),ZP(500),VX1(500),WS(220)
     1,VY1(500),VZ1(500),VX2(500),VY2(500),VZ2(500),VX3(500),VY3(500)
     2,VZ3(500),VX(8),VY(8),VZ(8),S1(650),S2(650),S3(650),V1(3),V2(3),V3
     3(3) ,PROB(15) ,XN(650),YN(650),ZN(650),TA(650),TX(650)
     4,TY(650),TZ(650)
      EQUIVALENCE  (KM,WS(211)),(KM,MK),(NP,WS(201)),(SYM,WS(210))
     1,(Y2,Y3),(MIX,WS(205)),(MIY,WS(206)),(MIZ,WS(207))
      INTEGER PAGE
      INTEGER SYM
    5 FORMAT(49H0XYZ POTENTIAL FLOW PROGRAM SECTION 5, VERSION 4   )
      WRITE (6,5)
C       A.  READ INPUT
      READ(5,25) NOBP,IEDIT5,IREAD
C       A.  READ THE OFF BODY POINTS
      NOB=NOBP
      DO 10 I=1,NOB
      READ(5,26)  XP(I),YP(I),ZP(I)
      IF (EOF(5) .EQ. 0.)  GO TO 10
      NOBP=I-1
      WRITE(6,9)  NOBP,NOB
    9 FORMAT(1H0,I5,31H OFF BODY POINTS SPECIFIED NOT ,I3)
      GO TO 11
   10 CONTINUE
   11 CONTINUE
   25 FORMAT(3I4)
   26 FORMAT(3F12.5)
      P=1.
      READ (03)  (PROB(I),I=1,15)
      WRITE (6,90) (PROB(I),I=1,15)
   90 FORMAT(1H0,18A4)
      WRITE(6,91)  NOBP,IEDIT5,IREAD
   91 FORMAT(8H0NOBP  =,I4 /8H IEDIT5=,I4/8H IREAD =,I4)
      WRITE(6,92)
   92 FORMAT(17H0 OFF BODY POINTS / 4H PT.,11X,1HX,12X,1HY,12X,1HZ)
      WRITE(6,93)  (I,XP(I),YP(I),ZP(I),I=1,NOBP)
   93 FORMAT(1X,I3,2X,3F13.5)
C       B.  READ THE PARAMETERS, T ARRAY AND SOURCE FROM TAPE 31
      READ (03)  (WS(I),I=1,220)
      READ (03) (TX(I),TY(I),TZ(I),XN(I),YN(I),ZN(I),TA(I),I=1,NP)
      READ (03)  SKIP
C
C FORMERLY:  WS(220) .EQ. 2.
C
      IF(WS(220) .EQ. 5.) READ(03) SKIP
      READ (03)  (S1(I),I=1,NP)
      READ (03)  (S2(I),I=1,NP)
      READ (03)  (S3(I),I=1,NP)
C       C.  READ THE FIRST BLOCK OF THE B ARRAY
      READ (04)  (B(I),I=1,241)
      K=1
      J=1
      DO 100 I=1,NOBP
C       D.  SET THE PARTIAL VELOCITY TO THE FREE STREAM VELOCITY
```

```
      VX1(I)=-1.0
      VY1(I)=0.
      VZ1(I)=0.
      VX2(I)=0.
      VY2(I)=-1.0
      VX3(I)=0.0
      VY3(I)=0.0
      VZ3(I)=-1.0
  100 VZ2(I)=0.
  290 IF(B(1)-P)291,295,291
  291 WRITE (6,98) B(1),P
   98 FORMAT(28H0 POINTS OUT OF ORDER  B(1)=,1F4.0,4H  P=,1F4.0)
      STOP
C       E.  START LOOP OVER THE QUADS.
  295 J=2
C       F1  PICK UP QUAD. INFORMATION
  296 X1=B(J)
      Y1=B(J+1)
      X2=B(J+2)
      Y2=B(J+3)
      X3=B(J+4)
      X4=B(J+5)
      Y4=B(J+6)
      XC=TX(K)
      YC=TY(K)
      ZC=TZ(K)
      A =TA(K)
      XX=B(J+7)
      YX=B(J+8)
      ZX=B(J+9)
      XY=B(J+10)
      YY=B(J+11)
      ZY=B(J+12)
C       F2  COMPUTE LENGTH OF SIDES OF QUAD.
      D12=SQ2F(X1,X2,Y1,Y2,0.,0.)
      D23=SQ2F(X2,X3,Y2,Y3,.0,.0)
      D34=SQ2F(X3,X4,Y3,Y4,.0,.0)
      D41=SQ2F(X4,X1,Y4,Y1,.0,.0)
C       F3  COMPUTE SLOPE OF SIDES
      IF(X2-X3)305,300,305
  300 CI23=1.
      GO TO 310
  305 CM23=(Y2-Y3)/(X2-X3)
      CI23=0.
  310 IF(X3-X4)315,311,315
  311 CI34=1.
      GO TO 320
  315 CM34=(Y4-Y3)/(X4-X3)
      CI34=0.
  320 IF(X4-X1)325,321,325
  321 CI41=1.
      GO TO 330
  325 CM41=(Y1-Y4)/(X1-X4)
      CI41=0.
  330 IF(X1-X2)335,331,335
  331 CI12=1.
      GO TO 340
  335 CM12=(Y2-Y1)/(X2-X1)
      CI12=0.
C       F4  COMPUTE QUADRAPOLE MOMENTS
  340 CIXX=B(J+17)
      CIXY=B(J+18)
```

```
      CIYY=B(J+19)
C       F5  COMPUTE SIN AND COS OF SLOPE ANGLE FOR EACH SIDE
      CY12=(Y2-Y1)/D12
      CY23=(Y3-Y2)/D23
      CY34=(Y4-Y3)/D34
      CY41=(Y1-Y4)/D41
      CX12=(X1-X2)/D12
      CX23=(X2-X3)/D23
      CX34=(X3-X4)/D34
      CX41=(X4-X1)/D41
C       F6  COMPUTE MAX DIAGINAL
      ST=SQ2F(X1,X3,Y1,Y3,0.,0.)
      ST2=SQ2F(X2,X4,Y2,Y4,.0,.0)
      IF(ST-ST2)341,342,342
  341 ST=ST2
C       G.  START LOOP OVER THE OFF BODY POINTS
  342 DO 530 JO=1,NOBP
      IS=1
      XCO=XP(JO)
      YCO=YP(JO)
      ZCO=ZP(JO)
      J1=1
  345 RPO=SQ2F(XC,XCO,YC,YCO,ZC ZCO)
C       H.  DETERMIN METHOD
      IF(RPO-ST*4)350,350,460
  350 X=(XCO-XC)*XX+(YCO-YC)*YX+(ZCO-ZC)*ZX
      Y=(XCO-XC)*XY+(YCO-YC)*YY+(ZCO-ZC)*ZY
      Z=(XCO-XC)*XN(K)+(YCO-YC)*YN(K)+(ZCO-ZC)*ZN(K)
      IF(RPO-ST*2.5)355,355,400
C       I.  COMPUTE INDUSED VELOCITY BY EXACT METHOD
  355 R1=SQ2F(X,X1,Y,Y1,Z,0.)
      R2=SQ2F(X,X2,Y,Y2,Z,0.)
      R3=SQ2F(X,X3,Y,Y3,Z,0.)
      R4=SQ2F(X,X4,Y,Y4,Z,0.)
      IF((R1+R2).LE.D12)  GO TO  1000
      IF((R3+R2).LE.D23)  GO TO  1000
      IF((R3+R4).LE.D34)  GO TO  1000
      IF((R1+R4).LE.D41)  GO TO  1000
      CLA1=ALOG((R1+R2-D12)/(R1+R2+D12))
      CLA2=ALOG((R2+R3-D23)/(R2+R3+D23))
      CLA3=ALOG((R3+R4-D34)/(R3+R4+D34))
      CLA4=ALOG((R4+R1-D41)/(R4+R1+D41))
      TVX=CY12*CLA1+CY23*CLA2+CY34*CLA3+CY41*CLA4
      TVY=CX12*CLA1+CX23*CLA2+CX34*CLA3+CX41*CLA4
      TVZ=0.
      IF(ABS(Z)-.001*ST)375,361,361
  361 ZSQ=Z**2
      E1=ZSQ+(X-X1)**2
      E2=ZSQ+(X-X2)**2
      E3=ZSQ+(X-X3)**2
      E4=ZSQ+(X-X4)**2
      H1=(Y-Y1)*(X-X1)
      H2=(Y-Y2)*(X-X2)
      H3=(Y-Y3)*(X-X3)
      H4=(Y-Y4)*(X-X4)
      IF(CI12)363,363,364
  363 WS1=(CM12*E1-H1)/(Z*R1)
      WS2=(CM12*E2-H2)/(Z*R2)
      AT1=ATAN(WS1)
      AT2=ATAN(WS2)
      TVZ=AT1-AT2
  364 IF(CI23)366,366,367
```

```
  366 AT3=ATAN((CM23*E2-H2)/(Z*R2))
      AT4=ATAN((CM23*E3-H3)/(Z*R3))
      TVZ=TVZ+AT3-AT4
  367 IF(CI34)368,368,369
  368 AT5=ATAN((CM34*E3-H3)/(Z*R3))
      AT6=ATAN((CM34*E4-H4)/(Z*R4))
      TVZ=TVZ+AT5-AT6
  369 IF(CI41)370,370,375
  370 AT7=ATAN((CM41*E4-H4)/(Z*R4))
      AT8=ATAN((CM41*E1-H1)/(Z*R1))
      TVZ=TVZ+AT7-AT8
  375 GO TO 450
C        J.  COMPUTE INDUSED VELOCITY BY QUADRAPOLE METHOD
  400 RPQ3=RPQ**3
      RPQ7=(RPQ3**2)*RPQ
      WS1= X/RPQ3
      XSQ=X**2
      YSQ=Y**2
      ZSQ=Z**2
      PS=YSQ+ZSQ-4.*XSQ
      QS=XSQ+ZSQ-4.*YSQ
      WS2=X*(9.*PS+30.*XSQ)/RPQ7
      WS3=3.*Y*PS/RPQ7
      WS4=3.*X*QS/RPQ7
      TVX=A*WS1-CIXY*WS3-CIXX*WS2-CIYY*WS4
      WS1=Y/RPQ3
      WS2=Y*(9.*QS+30.*YSQ)/RPQ7
      TVY=A*WS1-CIXX*WS3-CIXY*WS4-CIYY*WS2
      TVZ=Z*(A/RPQ3-3.*(CIXX*PS-5.*CIXY*X*Y+CIYY*QS)/RPQ7)
  450 VX(IS)=TVX*XX+TVY*XY+TVZ*XN(K)
      VY(IS)=TVX*YX+TVY*YY+TVZ*YN(K)
      VZ(IS)=TVX*ZX+TVY*ZY+TVZ*ZN(K)
      GO TO 470
C        K.  COMPUTE INDUSED VELOCITY BY MONOPOLE METHOD
  460 ARPQ3=A/(RPQ**3)
      VX(IS)=  (XCQ-XC)*ARPQ3
      VY(IS)=  (YCQ-YC)*ARPQ3
      VZ(IS)=  (ZCQ-ZC)*ARPQ3
C        L.  REFLECT OFF BODY POINT IN PLANE OF SYMETRY
  470 GO TO(480,485,490,495,500,505,510,515),IS
  480 V1(J1)=VX(1)
      V2(J1)=VX(1)
      V3(J1)=VX(1)
      V1(J1+1)=VY(1)
      V2(J1+1)=VY(1)
      V3(J1+1)=VY(1)
      V1(J1+2)=VZ(1)
      V2(J1+2)=VZ(1)
      V3(J1+2)=VZ(1)
      IF(SYM) 525,525,481
  481 IS=2
C              XZ SYMETRY
      YCQ=-YCQ
      GO TO 345
  485 IF(SYM-1)517,517,486
C              XY SYMETRY
  486 IS=3
      ZCQ=-ZCQ
      GO TO 345
  490 IS=4
      YCQ=-YCQ
      GO TO 345
```

```
  495 IF(SYM-2)516,516,496
C              YZ SYMETRY
  496 IS=5
      XCQ=-XCQ
      GO TO 345
  500 IS=6
      YCQ=-YCQ
      GO TO 345
  505 IS=7
      ZCQ=-ZCQ
      GO TO 345
  510 IS=8
      YCQ=-YCQ
      GO TO 345
C       M.  ADD CONTRIBUTIONS OF ALL REFLECTIONS
  515 V1(J1)=V1(J1)+UX(8)+UX(7)+UX(6)+UX(5)
      V2(J1)=V2(J1)-UX(8)+UX(7)+UX(6)-UX(5)
      V3(J1)=V3(J1)-UX(8)-UX(7)+UX(6)+UX(5)
      V1(J1+1)=V1(J1+1)-UY(8)+UY(7)+UY(6)-UY(5)
      V2(J1+1)=V2(J1+1)+UY(8)+UY(7)+UY(6)+UY(5)
      V3(J1+1)=V3(J1+1)+UY(8)-UY(7)+UY(6)-UY(5)
      V1(J1+2)=V1(J1+2)-UZ(8)-UZ(7)+UZ(6)+UZ(5)
      V2(J1+2)=V2(J1+2)+UZ(8)-UZ(7)+UZ(6)-UZ(5)
      V3(J1+2)=V3(J1+2)+UZ(8)+UZ(7)+UZ(6)+UZ(5)
  516 V1(J1)=V1(J1)+UX(4)+UX(3)
      V2(J1)=V2(J1)+UX(4)-UX(3)
      V3(J1)=V3(J1)-UX(4)-UX(3)
      V1(J1+1)=V1(J1+1)+UY(4)-UY(3)
      V2(J1+1)=V2(J1+1)+UY(4)+UY(3)
      V3(J1+1)=V3(J1+1)-UY(4)+UY(3)
      V1(J1+2)=V1(J1+2)-UZ(4)-UZ(3)
      V2(J1+2)=V2(J1+2)-UZ(4)+UZ(3)
      V3(J1+2)=V3(J1+2)+UZ(4)+UZ(3)
  517 V1(J1)=V1(J1)+UX(2)
      V2(J1)=V2(J1)-UX(2)
      V3(J1)=V3(J1)+UX(2)
      V1(J1+1)=V1(J1+1)-UY(2)
      V2(J1+1)=V2(J1+1)+UY(2)
      V3(J1+1)=V3(J1+1)-UY(2)
      V1(J1+2)=V1(J1+2)+UZ(2)
      V2(J1+2)=V2(J1+2)-UZ(2)
      V3(J1+2)=V3(J1+2)+UZ(2)
  525 L=P
      UX1(J0)=UX1(J0)+V1(1)*S1(L)
      UY1(J0)=UY1(J0)+V1(2)*S1(L)
      UZ1(J0)=UZ1(J0)+V1(3)*S1(L)
      UX2(J0)=UX2(J0)+V2(1)*S2(L)
      UY2(J0)=UY2(J0)+V2(2)*S2(L)
      UZ2(J0)=UZ2(J0)+V2(3)*S2(L)
      UX3(J0)=UX3(J0)+V3(1)*S3(L)
      UY3(J0)=UY3(J0)+V3(2)*S3(L)
      UZ3(J0)=UZ3(J0)+V3(3)*S3(L)
  530 CONTINUE
C       N.  END OF LOOP OVER OFF BODY POINTS
  585 P=P+1
      K=K+1
      J=J+20
      IF(K-NP   )586,586,599
  586 IF(J-241)296,590,590
C       O.  READ NEXT BLOCK OF B ARRAY IF NEEDED
  590 READ (04)  (B(I),I=1,241)
      J=2
```

```
      IF(B(1)-P)291,296,291
C       P.  END OF LOOP OVER QUADS
  599 CONTINUE
      PAGE = 1
      IF (IEDITS .EQ. 1) GO TO 825
  601 FORMAT(4H PT.,11X,1HX,12X,1HY,12X,1HZ,14X,2HUX,11X,2HUY,11X,2HUZ
     1,14X,2HCP)
  602 FORMAT(7H X FLOW)
  603 FORMAT(7H Y FLOW)
  604 FORMAT(7H Z FLOW)
  605 FORMAT(1H1,15A4,10X,15HOFF BODY POINTS ,10X,5HPAGE ,I3)
      IF (MIX.EQ.0)  GO TO 700
      WRITE(6,605) PROB,PAGE
      WRITE (6,602)
      WRITE (6,601)
      LINE=1
      LAST=53
  606 IF(NOBP-LAST)607,610,610
  607 LAST=NOBP
  610 DO 615 I=LINE,LAST
  611 FORMAT(1X,I13,2X,3F13.5,2X,3F13.5,3X,F13.5)
C       Q.  COMPUTE PRESSURE AND EDIT 3 BASIC FLOWS
      CP1=1.-(UX1(I)**2+UY1(I)**2+UZ1(I)**2)
  615 WRITE  (6,611) I,XP(I),YP(I),ZP(I),UX1(I),UY1(I),UZ1(I),CP1
      LINE=LAST+1
      LAST=LINE+54
      PAGE=PAGE+1
      IF(LINE-NOBP)620,620,700
  620 WRITE(6,605) PROB,PAGE
      WRITE (6,601)
      GO TO 606
  700 IF (MIY.EQ.0)  GO TO 800
      WRITE(6,605) PROB,PAGE
      WRITE (6,603)
      WRITE (6,601)
      LINE=1
      LAST=55
  706 IF(NOBP-LAST)707,710,710
  707 LAST=NOBP
  710 DO 715 I=LINE,LAST
      CP2=1.-(UX2(I)**2+UY2(I)**2+UZ2(I)**2)
  715 WRITE (6,611) I,XP(I),YP(I),ZP(I),UX2(I),UY2(I),UZ2(I),CP2
      LINE=LAST+1
      LAST=LINE+54
      PAGE=PAGE+1
      IF(LINE-NOBP)720,720,800
  720 WRITE(6,605) PROB,PAGE
      WRITE (6,601)
      GO TO 706
  800 IF (MIZ.EQ.0)  GO TO 825
      WRITE(6,605) PROB,PAGE
      WRITE (6,604)
      WRITE (6,601)
      LINE=1
      LAST=55
  806 IF(NOBP-LAST)807,810,810
  807 LAST=NOBP
  810 DO 815 I=LINE,LAST
      CP3=1.-(UX3(I)**2+UY3(I)**2+UZ3(I)**2)
  815 WRITE (6,611) I,XP(I),YP(I),ZP(I),UX3(I),UY3(I),UZ3(I),CP3
      LINE=LAST+1
      LAST=LINE+54
```

```
      PAGE=PAGE+1
      IF(LINE-NOBP)820,820,825
  820 WRITE(6,605) PROB,PAGE
      WRITE (6,601)
      GO TO 806
  825 J = 1
  826 IF (IREAD.EQ.0)  GO TO 827
      READ(5,26)  VX4,VY4,VZ4
      IF (EOF(5).NE. 0.)  GO TO 900
      GO TO 828
  827 VX4=WS(J)
      VY4 = WS(J+20)
      VZ4 = WS(J+40)
  828 CP=VX4**2+VY4**2+VZ4**2
      IF(CP)900,900,830
C       R.  COMPUTE FOURTH FLOW AND EDIT IT
  830 LINE=1
      LAST=51
      WRITE(6,605) PROB,PAGE
  831 FORMAT(19HOONSET FLOW    VX =,F7.3/15X,4HVY =,
     1F7.3/15X,4HVZ =,F7.3)
      WRITE (6,831) VX4,VY4,VZ4
      WRITE (6,601)
  835 IF(NOBP-LAST)837,840,840
  837 LAST=NOBP
  840 DO 845 I=LINE,LAST
      VXP=-VX4*VX1(I)-VY4*VX2(I)-VZ4*VX3(I)
      VYP=-VX4*VY1(I)-VY4*VY2(I)-VZ4*VY3(I)
      VZP=-VX4*VZ1(I)-VY4*VZ2(I)-VZ4*VZ3(I)
      CP4= 1.-(VXP**2+VYP**2+VZP**2)/CP
  845 WRITE (6,611) I,XP(I),YP(I),ZP(I),VXP,VYP,VZP,CP4
      LINE=LAST+1
      LAST=LINE+54
      PAGE=PAGE+1
      IF(LINE-NOBP)850,850,860
  850 WRITE(6,605) PROB,PAGE
      WRITE (6,601)
      GO TO 835
  860 J = J+1
      GO TO 826
 1000 WRITE(6,1001) JQ,L,XP(JQ),YP(JQ),ZP(JQ)
 1001 FORMAT(16HOOFF BODY POINT  ,I3,23H  ON BOUNDARY OF QUAD    ,I3/
     1        3H X=,F12.5,5X,2HY=,F12.5,5X,2HZ=,F12.5)
      GO TO 530
  900 CONTINUE
C       S.  REWIND TAPES AND STOP
      REWIND 03
      REWIND 04
      STOP 5
      END
      FUNCTION SQ2F(X1,X2,Y1,Y2,Z1,Z2)
      X=X1-X2
      Y=Y1-Y2
      Z=Z1-Z2
      RS=Z**2+Y**2+X**2
      R=ABS(X)+ABS(Y)+ABS(Z)+ 1.0E-20
      R=R+RS/R
      R=.25*R+RS/R
      R= R+RS/R
      SQ2F= .25*R+RS/R
      RETURN
      END
```

APPENDIX VI - XYZPF SECTION PF6

```
      PROGRAM PFP6(INPUT=128,TAPE16,OUTPUT=128,TAPE03,TAPE04,
     1             TAPE5=INPUT,TAPE6=OUTPUT,TAPE3=TAPE03,TAPE4=TAPE04)
C
C     XYZ POTENTIAL FLOW PROGRAM  VERSION 4  SECTION 6
C     COMPUTES VELOCITIES AND PRESSURE COEFFICIENTS FOR
C     OFF BODY STREAMLINES
C
      COMMON   XP(100),YP(100),ZP(100),VX1(100),WS(220)
     1,VY1(100),VZ1(100),VX2(100),VY2(100),VZ2(100),VX3(100),VY3(100)
     2,VZ3(100),VX(8),VY(8),VZ(8),S1(650),S2(650),S3(650),V1(3),V2(3),V3
     3(3) ,PROB(15) ,XN(650),YN(650),ZN(650),TX(650),TY(650),TZ(650)
     1,B(13000),       XT(100),YT(100),ZT(100),AP(5),GM(4),SKY(100),
     1 SKZ(100),SKX(100),DX(100),DY(100),DZ(100),CP(100) ,TA(650)
      EQUIVALENCE  (KM,WS(211)),(KM,MK),(NP,WS(201)),(SYM,WS(210))
     1,(Y2,Y3)
      INTEGER SYM ,P
C       A.  READ INPUT
      WRITE (6,5)
    6 FORMAT(3I4,4F12.5)
    8 FORMAT(3F12.5)
    5 FORMAT(49H0XYZ POTENTIAL FLOW PROGRAM SECTION 6, VERSION 4   )
    7 FORMAT (1X,9F12.5)
   20 FORMAT(1H1,I4,31H STREAMLINES TO BE COMPUTED AT   ,I4,10H STEPS OF
     1   ,F8.4,28H T FOR AN ONSET VELOCITY OF   ,3F8.4)
   21 FORMAT(1X,15HSTARTING POINTS/,3X,2HPT,5X,1HX,11X,1HY,11X,1HZ)
   22 FORMAT(1X,I4,3F12.5)
      READ (03)  (PROB(I),I=1,15)
      WRITE (6,90) (PROB(I),I=1,15)
   90 FORMAT(1H0,15A4)
C       B.  READ THE PARAMETERS, T ARRAY AND SOURCE FROM TAPE 31
      READ (03)  (WS(I),I=1,220)
      READ(03)  (TX(I),TY(I),TZ(I),XN(I),YN(I),ZN(I),TA(I),I=1,NP)
      READ (03)  SKIP
      IF (  WS(220) .EQ. 2.   )  READ(03) SKIP
      READ (03)  (S1(I),I=1,NP)
      READ (03)  (S2(I),I=1,NP)
      READ (03)  (S3(I),I=1,NP)
C       C.  READ THE B ARRAY
      WZ = NP
      WZ=(WZ+11.0)/12.0
      NB = WZ
      IS = 2
      IF=241
      DO 12 IP = 1,NB
      READ (04) P, (B(I),I=IS,IF)
      IS=IS+240
   12 IF=IF+240
      AP(1)= .5
      AP(2) = .5
      AP(3) = 1.
      AP(4)=0.
      AP(5)=0.
      GM(1) = 1./6.
      GM(2) = 1./3.
      GM(3) = 1./3.
   83 READ (5,6) NOBP,NST,IEND,DT,VXI,VYI,VZI
      VSQ=VXI**2+VYI**2+VZI**2
      NOB=NOBP
      DO 10 I=1,NOB
      READ(5, 8)  XP(I),YP(I),ZP(I)
```

```
      IF (EOF(5) .EQ. 0.)  GO TO 10
      NOBP=I-1
      WRITE(6,9)  NOBP,NOB
    9 FORMAT(1H0,I5,    28H STREAMLINES  SPECIFIED NOT ,I3)
      GO TO 11
   10 CONTINUE
   11 CONTINUE
      WRITE(16)  NOBP,NST,IEND,UXI,UYI,UZI
      WRITE(6,20)  NOBP,NST,DT,UXI,UYI,UZI
      WRITE(6,21)
      WRITE(6,22)  (I,XP(I),YP(I),ZP(I), I=1,NOBP)
C     NOBP - NUMBER OF STREAMLINES TO BE TRACED.
C     NST - NUMBER OF STATIONS AT WHICH STREAMLINES SHOULD BE COMPUTED.
      DO 15 I=1,NOBP
      XT(I) = XP(I)
      YT(I) = YP(I)
      ZT(I) = ZP(I)
      SKX(I)=0.
      SKY(I) = 0.
   15 SKZ(I) = 0.
      ITC=0
      IRK=5
   98 K=1
      P = 1
      J=1
      DO 100 I=1,NOBP
C       D.  SET THE PARTIAL VELOCITY TO THE FREE STREAM VELOCITY
      UX1(I)=-1.0
      UY1(I)=0.
      UZ1(I)=0.
      UX2(I)=0.
      UY2(I)=-1.0
      UX3(I)=0.0
      UY3(I)=0.0
      UZ3(I)=-1.0
  100 UZ2(I)=0.
C       E.  START LOOP OVER THE QUADS.
  295 J=2
C       F1  PICK UP QUAD. INFORMATION
  296 X1=B(J)
      Y1=B(J+1)
      X2=B(J+2)
      Y2=B(J+3)
      X3=B(J+4)
      X4=B(J+5)
      Y4=B(J+6)
      XC=TX(K)
      YC=TY(K)
      ZC=TZ(K)
      A =TA(K)
      XX=B(J+7)
      YX=B(J+8)
      ZX=B(J+9)
      XY=B(J+10)
      YY=B(J+11)
      ZY=B(J+12)
C       F2  COMPUTE LENGTH OF SIDES OF QUAD.
      D12=SQ2F(X1,X2,Y1,Y2,0.,0.)
      D23=SQ2F(X2,X3,Y2,Y3,.0,.0)
      D34=SQ2F(X3,X4,Y3,Y4,.0,.0)
      D41=SQ2F(X4,X1,Y4,Y1,.0,.0)
C       F3  COMPUTE SLOPE OF SIDES
```

```
      IF(X2-X3)305,300,305
  300 CI23=1.
      GO TO 310
  305 CM23=(Y2-Y3)/(X2-X3)
      CI23=0.
  310 IF(X3-X4)315,311,315
  311 CI34=1.
      GO TO 320
  315 CM34=(Y4-Y3)/(X4-X3)
      CI34=0.
  320 IF(X4-X1)325,321,325
  321 CI41=1.
      GO TO 330
  325 CM41=(Y1-Y4)/(X1-X4)
      CI41=0.
  330 IF(X1-X2)335,331,335
  331 CI12=1.
      GO TO 340
  335 CM12=(Y2-Y1)/(X2-X1)
      CI12=0.
C        F4  COMPUTE QUADRAPOLE MOMENTS
  340 CIXX=B(J+17)
      CIXY=B(J+18)
      CIYY=B(J+19)
C        F5  COMPUTE SIN AND COS OF SLOPE ANGLE FOR EACH SIDE
      CY12=(Y2-Y1)/D12
      CY23=(Y3-Y2)/D23
      CY34=(Y4-Y3)/D34
      CY41=(Y1-Y4)/D41
      CX12=(X1-X2)/D12
      CX23=(X2-X3)/D23
      CX34=(X3-X4)/D34
      CX41=(X4-X1)/D41
C        F6  COMPUTE MAX DIAGINAL
      ST=SQ2F(X1,X3,Y1,Y3,0.,0.)
      ST2=SQ2F(X2,X4,Y2,Y4,.0,.0)
      IF(ST-ST2)341,342,342
  341 ST=ST2
C        G.  START LOOP OVER THE OFF BODY POINTS
  342 DO 530 JQ=1,NOBP
      IS=1
      XCO=XP(JQ)
      YCO=YP(JQ)
      ZCO=ZP(JQ)
      J1=1
  345 RPO=SQ2F(XC,XCO,YC,YCO,ZC,ZCO)
C        H.  DETERMIN METHOD
      IF(RPO-ST*4)350,350,460
  350 X=(XCO-XC)*XX+(YCO-YC)*YX+(ZCO-ZC)*ZX
      Y=(XCO-XC)*XY+(YCO-YC)*YY+(ZCO-ZC)*ZY
      Z=(XCO-XC)*XN(K)+(YCO-YC)*YN(K)+(ZCO-ZC)*ZN(K)
      IF(RPO-ST*2.5)355,355,400
C        I   COMPUTE INDUSED VELOCITY BY EXACT METHOD
  355 R1=SQ2F(X,X1,Y,Y1,Z,0.)
      R2=SQ2F(X,X2,Y,Y2,Z,0.)
      R3=SQ2F(X,X3,Y,Y3,Z,0.)
      R4=SQ2F(X,X4,Y,Y4,Z,0.)
      CLA1=ALOG((R1+R2-D12)/(R1+R2+D12))
      CLA2=ALOG((R2+R3-D23)/(R2+R3+D23))
      CLA3=ALOG((R3+R4-D34)/(R3+R4+D34))
      CLA4=ALOG((R4+R1-D41)/(R4+R1+D41))
      TVX=CY12*CLA1+CY23*CLA2+CY34*CLA3+CY41*CLA4
```

```
      TUY=CX12*CLA1+CX23*CLA2+CX34*CLA3+CX41*CLA4
      TUZ=0.
      IF(ABS(Z)-.001*ST)375,361,361
  361 ZSQ=Z**2
      E1=ZSQ+(X-X1)**2
      E2=ZSQ+(X-X2)**2
      E3=ZSQ+(X-X3)**2
      E4=ZSQ+(X-X4)**2
      H1=(Y-Y1)*(X-X1)
      H2=(Y-Y2)*(X-X2)
      H3=(Y-Y3)*(X-X3)
      H4=(Y-Y4)*(X-X4)
      IF(CI12)363,363,364
  363 WS1=(CM12*E1-H1)/(Z*R1)
      WS2=(CM12*E2-H2)/(Z*R2)
      AT1=ATAN(WS1)
      AT2=ATAN(WS2)
      TUZ=AT1-AT2
  364 IF(CI23)366,366,367
  366 AT3=ATAN((CM23*E2-H2)/(Z*R2))
      AT4=ATAN((CM23*E3-H3)/(Z*R3))
      TUZ=TUZ+AT3-AT4
  367 IF(CI34)368,368,369
  368 AT5=ATAN((CM34*E3-H3)/(Z*R3))
      AT6=ATAN((CM34*E4-H4)/(Z*R4))
      TUZ=TUZ+AT5-AT6
  369 IF(CI41)370,370,375
  370 AT7=ATAN((CM41*E4-H4)/(Z*R4))
      AT8=ATAN((CM41*E1-H1)/(Z*R1))
      TUZ=TUZ+AT7-AT8
  375 GO TO 450
C        J.  COMPUTE INDUSED VELOCITY BY QUADRAPOLE METHOD
  400 RPQ3=RPQ**3
      RPQ7=(RPQ3**2)*RPQ
      WS1= X/RPQ3
      XSQ=X**2
      YSQ=Y**2
      ZSQ=Z**2
      PS=YSQ+ZSQ-4.*XSQ
      QS=XSQ+ZSQ-4.*YSQ
      WS2=X*(9.*PS+30.*XSQ)/RPQ7
      WS3=3.*Y*PS/RPQ7
      WS4=3.*X*QS/RPQ7
      TUX=A*WS1-CIXY*WS3-CIXX*WS2-CIYY*WS4
      WS1=Y/RPQ3
      WS2=Y*(9.*QS+30.*YSQ)/RPQ7
      TUY=A*WS1-CIXX*WS3-CIXY*WS4-CIYY*WS2
      TUZ=Z*(A/RPQ3-3.*(CIXX*PS-5.*CIXY*X*Y+CIYY*QS)/RPQ7)
  450 UX(IS)=TUX*XX+TUY*XY+TUZ*XN(K)
      UY(IS)=TUX*YX+TUY*YY+TUZ*YN(K)
      UZ(IS)=TUX*ZX+TUY*ZY+TUZ*ZN(K)
      GO TO 470
C        K.  COMPUTE INDUSED VELOCITY BY MONOPOLE METHOD
  460 ARPQ3=A/(RPQ**3)
      UX(IS)=  (XCQ-XC)*ARPQ3
      UY(IS)=  (YCQ-YC)*ARPQ3
      UZ(IS)=  (ZCQ-ZC)*ARPQ3
C        L.  REFLECT OFF BODY POINT IN PLANE OF SYMETRY
  470 GO TO(480,485,490,495,500,505,510,515),IS
  480 U1(J1)=UX(1)
      U2(J1)=UX(1)
      U3(J1)=UX(1)
```

```
      V1(J1+1)=VY(1)
      V2(J1+1)=VY(1)
      V3(J1+1)=VY(1)
      V1(J1+2)=VZ(1)
      V2(J1+2)=VZ(1)
      V3(J1+2)=VZ(1)
      IF(SYM) 525,525,481
  481 IS=2
C               XZ SYMETRY
      YCQ=-YCQ
      GO TO 345
  485 IF(SYM-1)517,517,486
C               XY SYMETRY
  486 IS=3
      ZCQ=-ZCQ
      GO TO 345
  490 IS=4
      YCQ=-YCQ
      GO TO 345
  495 IF(SYM-2)516,516,496
C               YZ SYMETRY
  496 IS=5
      XCQ=-XCQ
      GO TO 345
  500 IS=6
      YCQ=-YCQ
      GO TO 345
  505 IS=7
      ZCQ=-ZCQ
      GO TO 345
  510 IS=8
      YCQ=-YCQ
      GO TO 345
C         M.  ADD CONTRIBUTIONS OF ALL REFLECTIONS
  515 V1(J1)=V1(J1)+VX(8)+VX(7)+VX(6)+VX(5)
      V2(J1)=V2(J1)-VX(8)+VX(7)+VX(6)-VX(5)
      V3(J1)=V3(J1)-VX(8)-VX(7)+VX(6)+VX(5)
      V1(J1+1)=V1(J1+1)-VY(8)+VY(7)+VY(6)-VY(5)
      V2(J1+1)=V2(J1+1)+VY(8)+VY(7)+VY(6)+VY(5)
      V3(J1+1)=V3(J1+1)+VY(8)-VY(7)+VY(6)-VY(5)
      V1(J1+2)=V1(J1+2)-VZ(8)-VZ(7)+VZ(6)+VZ(5)
      V2(J1+2)=V2(J1+2)+VZ(8)-VZ(7)+VZ(6)-VZ(5)
      V3(J1+2)=V3(J1+2)+VZ(8)+VZ(7)+VZ(6)+VZ(5)
  516 V1(J1)=V1(J1)+VX(4)+VX(3)
      V2(J1)=V2(J1)+VX(4)-VX(3)
      V3(J1)=V3(J1)-VX(4)-VX(3)
      V1(J1+1)=V1(J1+1)+VY(4)-VY(3)
      V2(J1+1)=V2(J1+1)+VY(4)+VY(3)
      V3(J1+1)=V3(J1+1)-VY(4)+VY(3)
      V1(J1+2)=V1(J1+2)-VZ(4)-VZ(3)
      V2(J1+2)=V2(J1+2)-VZ(4)+VZ(3)
      V3(J1+2)=V3(J1+2)+VZ(4)+VZ(3)
  517 V1(J1)=V1(J1)+VX(2)
      V2(J1)=V2(J1)-VX(2)
      V3(J1)=V3(J1)+VX(2)
      V1(J1+1)=V1(J1+1)-VY(2)
      V2(J1+1)=V2(J1+1)+VY(2)
      V3(J1+1)=V3(J1+1)-VY(2)
      V1(J1+2)=V1(J1+2)+VZ(2)
      V2(J1+2)=V2(J1+2)-VZ(2)
      V3(J1+2)=V3(J1+2)+VZ(2)
  525 VX1(JQ)=VX1(JQ)+V1(1)*S1(P)
```

```
      UY1(JQ)=UY1(JQ)+V1(2)*S1(P)
      UZ1(JQ)=UZ1(JQ)+V1(3)*S1(P)
      UX2(JQ)=UX2(JQ)+V2(1)*S2(P)
      UY2(JQ)=UY2(JQ)+V2(2)*S2(P)
      UZ2(JQ)=UZ2(JQ)+V2(3)*S2(P)
      UX3(JQ)=UX3(JQ)+V3(1)*S3(P)
      UY3(JQ)=UY3(JQ)+V3(2)*S3(P)
  530 UZ3(JQ)=UZ3(JQ)+V3(3)*S3(P)
C       N.  END OF LOOP OVER OFF BODY POINTS
  585 P=P+1
      K=K+1
      J=J+20
      IF(K-NP   )296,296,599
C       P.  END OF LOOP OVER QUADS
  599 H=AP(IRK)*DT
      DO 730 I = 1,NOBP
   63 FORMAT(2X,I3,3F12.5,9X,4F12.5)
      DX(I)=-(UXI*UX1(I)+UYI*UX2(I)+UZI*UX3(I))
      DY(I)=-(UXI*UY1(I)+UYI*UY2(I)+UZI*UY3(I))
  730 DZ(I)=-(UXI*UZ1(I)+UYI*UZ2(I)+UZI*UZ3(I))
      IF(IRK.EQ.5) GO TO 900
      IF(IRK.EQ.4) GO TO 800
      DO 750 I=1,NOBP
      XP(I)=XT(I)+DX(I)*H
      YP(I)=YT(I)+DY(I)*H
      ZP(I)=ZT(I)+DZ(I)*H
      SKX(I)=SKX(I)+GM(IRK)*DX(I)
      SKY(I)=SKY(I)+GM(IRK)*DY(I)
  750 SKZ(I)=SKZ(I)+GM(IRK)*DZ(I)
      IRK = IRK + 1
      GO TO 98
  800 H=DT
      DO 830 I=1,NOBP
      DX(I)=-(UXI*UX1(I)+UYI*UX2(I)+UZI*UX3(I))
      DY(I)=-(UXI*UY1(I)+UYI*UY2(I)+UZI*UY3(I))
      DZ(I)=-(UXI*UZ1(I)+UYI*UZ2(I)+UZI*UZ3(I))
      XP(I)=XT(I)+H*DX(I)/6.+SKX(I)*H
      XT(I)=XP(I)
      YP(I)=YT(I)+H*DY(I)/6.+SKY(I)*H
      YT(I)=YP(I)
      ZP(I)=ZT(I)+H*DZ(I)/6.+SKZ(I)*H
      ZT(I)=ZP(I)
      SKX(I)=0.
      SKY(I) = 0.
  830 SKZ(I) = 0.
      IRK = 5
      GO TO 98
  900 IRK = 1
      DO 905 I=1,NOBP
      DSQ=DX(I)**2+DY(I)**2+DZ(I)**2
      CP(I)=1.-DSQ/USQ
  905 CONTINUE
      WRITE(6,61)  ITC
   61 FORMAT(6H0 STEP,I4/)
      WRITE(6,62)
   62 FORMAT(3X,4HLINE,5X,1HX,11X,1HY,11X,1HZ,20X,2HUX,10X,2HUY,
     1       10X,2HUZ,10X,2HCP)
      WRITE(6,63) (I,XP(I),YP(I),ZP(I),DX(I),DY(I),DZ(I),CP(I),I=1,NOBP)
      WRITE(16)  ( XP(I),YP(I),ZP(I), I=1,NOBP )
      IF(ITC.EQ.NST)  GO TO 910
      ITC=ITC+1
      GO TO 599
```

```
910 IF(IEND.EQ.0 ) GO TO 83
    REWIND 03
    REWIND 04
    ENDFILE 16
    REWIND 16
    STOP 6
    END
    FUNCTION SQ2F(X1,X2,Y1,Y2,Z1,Z2)
    X=X1-X2
    Y=Y1-Y2
    Z=Z1-Z2
    RS=Z**2+Y**2+X**2
    R=ABS(X)+ABS(Y)+ABS(Z)+ 1.0E-20
    R=.3422*(R+(RS+RS)/R)
    R= R+RS/R
    SQ2F= .25*R+RS/R
    RETURN
    END
```

APPENDIX VII - XYZPF SECTION PF7

```
      PROGRAM PFP7(TAPE7,INPUT=128,OUTPUT=128,TAPE5=INPUT,TAPE17,
     1TAPE6=OUTPUT,TAPE03,TAPE04,TAPE3=TAPE03,TAPE4=TAPE04)
C
C     XYZ POTENTIAL FLOW PROGRAM  VERSION 4 AND VERSION 5  SECTION 7
C     COMPUTES VELOCITIES AND PRESSURE COEFFICIENTS FOR
C     ON BODY STREAMLINES
C
      COMMON    X(658),Y(658),Z(658),XN(650),YN(650)
     1,ZN(650),UX1(650),UY1(650),UZ1(650),UX2(650),UY2(650)
     2,UZ2(650),UX3(650),UY3(650),UZ3(650),XC1(658),YC1(658)
     3,XC2(658),YC2(658),XC3(658),XC4(658),YC4(658),
     4X3(658),Y3(658),Z3(658),X4(658),Y4(658),Z4(658)
      DIMENSION XL(150),YL(150),ZL(150),UX(150),UY(150),UZ(150),
     1CP(150),GK1(150),GK2(150),H2(150),STML(150),UABS(150),NQUAD(150)
     5,DMX(650),PROB(15),YC3(658),SF(5),XCR(5),YCR(5)    ,
     7NSP(50),WS(220) ,XST(50),YST(50),ZST(50)
      EQUIVALENCE (WS(201),NP),(YC3,YC2)
      READ(03)(PROB(I),I=1,15)
      READ(03)(WS(I),I=1,220)
      READ(03)(X(I),Y(I),Z(I),XN(I),YN(I),ZN(I),
     1SKIP,I=1,NP)
      READ(03)SKIP
      IVER =WS(220)
      WRITE(6,5) IVER
    5 FORMAT(46HOXYZ POTENTIAL FLOW PROGRAM SECTION 7, VERSION ,I2)
      IF (IVER.EQ.5)  READ(03) SKIP
      READ(03)SKIP
      READ(03)SKIP
      READ(03)SKIP
      READ(03)(UX1(I),UY1(I),UZ1(I),I=1,NP)
      READ(03)(UX2(I),UY2(I),UZ2(I),I=1,NP)
      READ(03)(UX3(I),UY3(I),UZ3(I),I=1,NP)
      REWIND 03
      NB=(NP+11)/12
      DO 80 I=1,NB
      IFN=I*12
      IS=IFN-11
      READ(04) Q,(XC1(J),YC1(J),XC2(J),
     1YC2(J),XC3(J),XC4(J),YC4(J),X3(J),Y3(J),
     2Z3(J),X4(J),Y4(J),Z4(J),(SKIP,K=1,7),J=IS,IFN )
      NQ=Q
      IF(NQ.NE.IS) GO TO 450
   80 CONTINUE
      REWIND 04
      DO 90 I=1,NP
      D1=(XC1(I)**2+YC1(I)**2)*1.01
      D2=(XC2(I)**2+YC2(I)**2)*1.01
      D3=(XC3(I)**2+YC3(I)**2)*1.01
      D4=(XC4(I)**2+YC4(I)**2)*1.01
   90 DMX(I)=AMAX1(D1,D2,D3,D4)
   11 FORMAT(3F12.4,3I4,F12.4)
   12 FORMAT(3F12.4, I4)
      MID=75
  100 READ(5,11) UXI,UYI,UZI,NLIN,MAXJ,IWRITE,AMACH
      IF (EOF(5).NE.0.)  NLIN=0
      MXJ=MAXJ
      IF ( MAXJ .LE. 0  .OR.  MAXJ .GT. NP/2) MAXJ = NP/2
      MINJ=MID-MAXJ
      MAXJ=MID+MAXJ
      IF (MAXJ.GT.MID*2) MAXJ=MID*2
```

```
      IF ( MINJ .LT.1)  MINJ = 1
      WRITE(7 )  NLIN
      WRITE(17)  NLIN,UXI,UYI,UZI
      IF(NLIN.LE.0) GO TO 550
      WRITE(6,30)  (PROB(I),I=1,15)
      WRITE(6,34) UXI,UYI,UZI,NLIN,MXJ,IWRITE,AMACH
   34 FORMAT(34H0ON BODY STREAMLINES - INPUT DATA  /6H UXI =,F10.5/
     16H UYI =,F10.5/6H UZI =,F10.5/6H NLIN=,I10/
     2 6H JMAX=,I10,/,8H IWRITE=,I10,/,9H MACH NO=,F10.5)
      WRITE(6,38)
   38 FORMAT(27H0STREAMLINE STARTING POINTS/5H LINE,11X,1HX,12X,1HY,
     1  12X,1HZ,10X,3HNSP)
      LIN=NLIN
      DO 45 I=1,LIN
      READ(5,12)  XST(I) ,YST(I),ZST(I),NSP(I)
      IF (EOF(5).EQ.0.)  GO TO 45
      NLIN=I-1
      WRITE(6,42)  NLIN,LIN
   42 FORMAT(1H0,I5,28H STREAMLINES SPECIFIED NOT    ,I3)
      IF(NLIN.LE.0) GO TO 550
      GO TO 48
   45 WRITE(6,46)  I,XST(I),YST(I),ZST(I),NSP(I)
   46 FORMAT(1X,I3,2X,3F13.5,I9)
   48 CONTINUE
      USQ=UXI**2+UYI**2+UZI**2
      IF (AMACH  EQ. 0.) GO TO 1130
C *** COMPUTE CRITICAL MACH NO.
      USD = 0
      DO 1100 I=1,NP
      US = (UXI*UX1(I)+UYI*UX2(I)+UZI*UX3(I))**2 +
     1     (UXI*UY1(I)+UYI*UY2(I)+UZI*UY3(I))**2 +
     2     (UXI*UZ1(I)+UYI*UZ2(I)+UZI*UZ3(I))**2
      IF (US .GT. USD) USD = US
 1100 CONTINUE
      U = SQRT(USD/USQ)
      CMNA = 1./U
      DO 1110 I=1,3
      CMNB = (((CMNA**2+5.)/6.)**1.75)/U
      CMNC = (((CMNB**2+5.)/6.)**1.75)/U
 1110 CMNA = (CMNA*CMNC-CMNB**2)/(CMNA+CMNC-2.*CMNB)
      WRITE(6,1120) CMNA
 1120 FORMAT(21H  CRITICAL MACH NO. =,F5.3)
 1130 CONTINUE
C     START LOOP OVER STREAMLINES
      DO 400 LL=1,NLIN
      DIRT=1.
  101 JI=1
      AF=1.
      UX(MID)=0
      UY(MID)=0.
      UZ(MID)=0.
      CP(MID)=0
      H2(MID)=1.
      GK1(MID)=0.
      GK2(MID)=0.
      STML(MID)=0
  102 NO=NSP(LL)
      LNO=NO
      XL(MID)=XST(LL)
      YL(MID)=YST(LL)
      ZL(MID)=ZST(LL)
      J=MID
```

```
      JL=J
C     SEPARATE CALCULATION OF SECOND
C     POINT FROM MAIN LOOP
      XLT=(XL(J)-X(NQ))*X3(NQ)+(YL(J)-Y(NQ))*Y3(NQ)
     1                          +(ZL(J)-Z(NQ))*Z3(NQ)
      YLT=(XL(J)-X(NQ))*X4(NQ)+(YL(J)-Y(NQ))*Y4(NQ)
     1                          +(ZL(J)-Z(NQ))*Z4(NQ)
      XL(J)=XLT*X3(NQ)+YLT*X4(NQ)+X(NQ)
      YL(J)=XLT*Y3(NQ)+YLT*Y4(NQ)+Y(NQ)
      ZL(J)=XLT*Z3(NQ)+YLT*Z4(NQ)+Z(NQ)
  105 IQT=MOD(NQ,4) + 1
      GO TO (630,600,610,620)  IQT
  600 NR=NQ+1
      NU=NQ+2
      GO TO 107
  610 NR=NQ+2
      NU=NQ-1
      GO TO 107
  620 NR=NQ-2
      NU=NQ+1
      GO TO 107
  630 NR=NQ-1
      NU=NQ-2
  107 UXQ=-(UXI*UX1(NQ)+UYI*UX2(NQ)+UZI*UX3(NQ))
      UYQ=-(UXI*UY1(NQ)+UYI*UY2(NQ)+UZI*UY3(NQ))
      UZQ=-(UXI*UZ1(NQ)+UYI*UZ2(NQ)+UZI*UZ3(NQ))
      UXR=-(UXI*UX1(NR)+UYI*UX2(NR)+UZI*UX3(NR))
      UYR=-(UXI*UY1(NR)+UYI*UY2(NR)+UZI*UY3(NR))
      UZR=-(UXI*UZ1(NR)+UYI*UZ2(NR)+UZI*UZ3(NR))
      UXU=-(UXI*UX1(NU)+UYI*UX2(NU)+UZI*UX3(NU))
      UYU=-(UXI*UY1(NU)+UYI*UY2(NU)+UZI*UY3(NU))
      UZU=-(UXI*UZ1(NU)+UYI*UZ2(NU)+UZI*UZ3(NU))
C     TRANSFORM VELOCITIES TO QUAD SYSTEM
      UQ=UXQ*X3(NQ)+UYQ*Y3(NQ)+UZQ*Z3(NQ)
      VQ=UXQ*X4(NQ)+UYQ*Y4(NQ)+UZQ*Z4(NQ)
      CSR=1./(XN(NQ)*XN(NR)+YN(NQ)*YN(NR)+ZN(NQ)*ZN(NR))
      UT=UXR*X3(NR)+UYR*Y3(NR)+UZR*Z3(NR)
      VT=(UXR*X4(NR)+UYR*Y4(NR)+UZR*Z4(NR))*CSR
      XXR=   (X3(NR)*X3(NQ)+Y3(NR)*Y3(NQ)+Z3(NR)*Z3(NQ))
      XYR=   (X4(NR)*X3(NQ)+Y4(NR)*Y3(NQ)+Z4(NR)*Z3(NQ))
      UR=UT*XXR+VT*XYR
      YXR=   (X3(NR)*X4(NQ)+Y3(NR)*Y4(NQ)+Z3(NR)*Z4(NQ))
      YYR=   (X4(NR)*X4(NQ)+Y4(NR)*Y4(NQ)+Z4(NR)*Z4(NQ))
      VR=UT*YXR+VT*YYR
      UU=UXU*X3(NQ)+UYU*Y3(NQ)+UZU*Z3(NQ)
      CSU=   (XN(NQ)*XN(NU)+YN(NQ)*YN(NU)+ZN(NQ)*ZN(NU))
      VU=(UXU*X4(NQ)+UYU*Y4(NQ)+UZU*Z4(NQ))/CSU
C     FIND RELATIVE COORDINATES OF NEIGHBORING QUADS
      XD=X(NR)-X(NQ)
      YD=Y(NR)-Y(NQ)
      ZD=Z(NR)-Z(NQ)
      XT =XD*X3(NR)+YD*Y3(NR)+ZD*Z3(NR)
      YTT=XD*X4(NR)+YD*Y4(NR)+ZD*Z4(NR)
      ZT =XD*XN(NR)+YD*YN(NR)+ZD*ZN(NR)
      YT=(-4*SQRT(YTT**2+ZT**2)+YTT*CSR+YTT)*CSR*.16666667
      XR=XT*XXR+YT*XYR
      YR=XT*YXR+YT*YYR
      XD=X(NU)-X(NQ)
      YD=Y(NU)-Y(NQ)
      ZD=Z(NU)-Z(NQ)
      YU=XD*X3(NQ)+YD*Y3(NQ)+ZD*Z3(NQ)
      YT=XD*X4(NQ)+YD*Y4(NQ)+ZD*Z4(NQ)
```

```
      ZT=XD*XN(NQ)+YD*YN(NQ)+ZD*ZN(NQ)
      VU=(4.*SQRT(YT**2+ZT**2)+YT/CSU+YT)*.16666667
C     FIND COEFFICIENTS OF VELOCITY FUNCTIONS
      DEN=1./(XR*VU-XU*VR)
      U1=((UR-UQ)*VU-(UU-UQ)*VR) *DEN
      U2=-((UR-UQ)*XU-(UU-UQ)*XR )*DEN
      V1=((VR-VQ)*VU-(VU-VQ)*VR) *DEN
      V2=-((VR-VQ)*XU-(VU-VQ)*XR )*DEN
C     FIND VELOCITY AT STREAMLINE POINT
      USL=UQ+U1*XLT+U2*YLT
      VSL=VQ+V1*XLT+V2*YLT
      UXP=USL*X3(NQ)+VSL*X4(NQ)
      UYP=USL*Y3(NQ)+VSL*Y4(NQ)
      UZP=USL*Z3(NQ)+VSL*Z4(NQ)
C     FIND GEODESIC CURVATURES  GK1,GK2
      VSQD=USL**2+VSL**2
      DEN=VSQD*SQRT(VSQD)
      GK1P=(USL*(USL*U2-USL*V2)-VSL*(USL*U1-USL*V1))/DEN
      GK2P=(USL*(USL*U1+USL*U2)-USL*(USL*V1+USL*V2))/DEN
C     FIND LOCAL STREAM FUNCTION
      CXY=(U1*UQ**2-V2*UQ**2)/VSQD
      CYY=U2-UQ*VQ*(U1+V2)/VSQD
      CXX=U2-CYY-V1
      CO=XLT*VQ-YLT*UQ-CXY*XLT*YLT-CYY*YLT**2-CXX*XLT**2
C     FIND STREAM FUNCTION AT CORNER POINTS
      XCR(1)=XC1(NQ)
      XCR(2)=XC2(NQ)
      XCR(3)=XC3(NQ)
      XCR(4)=XC4(NQ)
      XCR(5)=XCR(1)
      YCR(1)=YC1(NQ)
      YCR(2)=YC2(NQ)
      YCR(3)=YC3(NQ)
      YCR(4)=YC4(NQ)
      YCR(5)=YCR(1)
      DO 110 N=1,4
  110 SF(N)=CO-VQ*XCR(N)+UQ*YCR(N)+CXY*XCR(N)*YCR(N)+CYY*YCR(N)**2
     1       +CXX*XCR(N)**2
      SF(5)=SF(1)
      TEST=0
      DO 120 N=1,4
      IF ( SF(N)*SF(N+1) .GE. 0. )  GO TO 120
      XM=(XCR(N)+XCR(N+1))*.5
      YM=(YCR(N)+YCR(N+1))*.5
C     FIND INTERSECTION WITH SIDE OF QUAD.
      SFM=CO-VQ*XM+UQ*YM+CXY*XM*YM+CYY*YM**2+CXX*XM**2
      AC=2.*(SF(N)-2.*SFM+SF(N+1))
      BC=3.*SF(N)-4.*SFM+SF(N+1)
      IF (AC .EQ. 0)     GO TO 113
      SR=SQRT(BC**2-4.*AC*SF(N) )
      TP=(BC+SR)/(2.*AC)
      IF (TP .LE. 1. AND. TP .GE. 0. )  GO TO 115
      TP=(BC-SR)/(2.*AC)
      GO TO 115
  113 IF (BC .EQ. 0 ) GO TO 120
      TP=SF(N)/BC
  115 XNP=(1.-TP)*XCR(N)+TP*XCR(N+1)
      YNP=(1.-TP)*YCR(N)+TP*YCR(N+1)
      TESTP=((XNP-XLT)*UQ+(YNP-YLT)*VQ)*DIRT
      IF (TESTP .LE. TEST)  GO TO 120
      TEST=TESTP
      XNT=XNP
```

```
      YNT=YNP
  120 CONTINUE
      IF( TEST .EQ. 0)  GO TO 280
C     AVERAGE LAST VELOCITY AND CURVATURE
      UX(J)=(UX(J)+UXP)*AF
      UY(J)=(UY(J)+UYP)*AF
      UZ(J)=(UZ(J)+UZP)*AF
      GK1(J)=(GK1(J)+GK1P)*AF
      GK2(J)=(GK2(J)+GK2P)*AF
      H2(J)=H2(JL)*(2.-GK1(JL)*(STML(J)-STML(JL)))/(2.+GK1(J)*(
     1       STML(J)-STML(JL)))
      CP(J)=1.-(UX(J)**2+UY(J)**2+UZ(J)**2)/USQ
      UABS(J)=SQRT(1.-CP(J))
C     COMPUTE VELOCITY AT NEXT POINT
      NQUAD(J)=NQ
      JL=J
      J=J+JI
      USL=UQ+XNT*U1+YNT*U2
      VSL=VQ+XNT*V1+YNT*V2
      UX(J)=USL*X3(NQ)+VSL*X4(NQ)
      UY(J)=USL*Y3(NQ)+VSL*Y4(NQ)
      UZ(J)=USL*Z3(NQ)+VSL*Z4(NQ)
C     COMPUTE GEODESIC CURVATURES
      USQD=USL**2+VSL**2
      DEN=USQD*SQRT(USQD)
      GK1(J)=(USL*(USL*U2-USL*V2)-VSL*(USL*U1-VSL*V1))/DEN
      GK2(J)=(USL*(USL*U1+VSL*U2)-VSL*(USL*V1+VSL*V2))/DEN
      CORD=SQRT((XNT-XLT)**2+(YNT-YLT)**2 )*DIRT
      STML(J)=STML(JL)+CORD
C     COMPUTE H2
      H2(J)=H2(JL)*(2.-CORD*GK1(JL))/(2.+CORD*GK1(J))
      CP(J)=1.-USQD/USQ
      UABS(J)=SQRT(1.-CP(J))
      AF=.5
      LNQ=NQ
      XL(J)=XNT*X3(NQ)+YNT*X4(NQ)+X(NQ)
      YL(J)=XNT*Y3(NQ)+YNT*Y4(NQ)+Y(NQ)
      ZL(J)=XNT*Z3(NQ)+YNT*Z4(NQ)+Z(NQ)
      IF ( J .LE. MINJ  .OR.  J .GE. MAXJ )   GO TO 280
C     FIND NEXT QUAD.
      I=1
  250 NQ=I
      IF(I.EQ.LNQ) GO TO 290
      TEST=(XL(J)-X(I))**2+(YL(J)-Y(I))**2+
     1(ZL(J)-Z(I))**2-DMX(I)
      IF(TEST.GT.0.) GO TO 280
      DS1=(XC1(I)-XC2(I))**2+(YC1(I)-YC2(I))**2
      DS2=(XC2(I)-XC3(I))**2+(YC2(I)-YC3(I))**2
      DS3=(XC3(I)-XC4(I))**2+(YC3(I)-YC4(I))**2
      DS4=(XC4(I)-XC1(I))**2+(YC4(I)-YC1(I))**2
      XLT=(XL(J)-X(I))*X3(I)+(YL(J)-Y(I))*Y3(I)+
     1(ZL(J)-Z(I))*Z3(I)
      YLT=(XL(J)-X(I))*X4(I)+(YL(J)-Y(I))*Y4(I)+
     1(ZL(J)-Z(I))*Z4(I)
      ZLT=(XL(J)-X(I))*XN(I)+(YL(J)-Y(I))*YN(I)+
     1(ZL(J)-Z(I))*ZN(I)
      ZSQ=ZLT**2
      TEST=ZSQ-.1*DMX(I)
      IF(TEST.GT.0.) GO TO 280
      RC1=SQRT(ZSQ+(XLT-XC1(I))**2+(YLT-YC1(I))
     1**2)
      RC2=SQRT(ZSQ+(XLT-XC2(I))**2+(YLT-YC2(I))**2)
```

```
      RC3=SQRT(ZSQ+(XLT-XC3(I))**2+(YLT-YC3(I))**2)
      RC4=SQRT(ZSQ+(XLT-XC4(I))**2+(YLT-YC4(I))**2)
      TEST= ((RC1+RC2)**2)-DS1 *1.21
      IF(TEST.LT.0.) GO TO 105
      TEST= ((RC2+RC3)**2)-DS2 *1.21
      IF(TEST.LT.0.) GO TO 105
      TEST= ((RC3+RC4)**2)-DS3 *1.21
      IF(TEST.LT.0.) GO TO 105
      TEST= ((RC4+RC1)**2)-DS4 *1.21
      IF(TEST.LT.0.) GO TO 105
  280 I=I+1
      IF(I.LE.NP) GO TO 250
  282 IF (DIRT .LT. 0.)  GO TO 285
      DIRT=-1.
      JI=-1
      JMAX=J
      GO TO 102
  285 JMIN=J
      SS=STML(JMIN)
      DO 290 J=JMIN,JMAX
  290 STML(J)=STML(J)-SS
      JMN=JMIN+1
      JMX=JMAX-2
      AF=1.
      L=JMN
      WRITE(6,30)(PROB(I),I=1,15)
   30 FORMAT(1H1,15A4)
      WRITE(6,20)UXI,UYI,UZI
   20 FORMAT( 18H0 ONSET FLOW, UXI=,F6.3,2X,4HUYI=,F6.3,2X,4HUZI=,F6.3)
      WRITE(6,50)  LL,NSP(LL),XST(LL),YST(LL),ZST(LL)
   50 FORMAT(11H0 LINE NO. ,I2,31H PASSING THROUGH QUADRILATERAL  ,I3,
     1       28H  WITH STARTING POINT,    X=,F12.5,2X,2HY=,F12.5,2X,
     2       2HZ=,F12.5 //)
      IF (JMIN.LE.MINJ .OR. JMAX.GE.MAXJ)  WRITE(6 55)
   65 FORMAT(35H PROBABLE ERROR - LINE IS VERY LONG)
      DO 330 J=JMN,JMX
      IF ( (STML(J+2)-STML(L-1)).LT. 8.*(STML(J+1)-STML (L)))  GO TO 320
      WRITE(6,310)  XL(L),YL(L),ZL(L),XL(J+1),YL(J+1),ZL(J+1)
  310 FORMAT(14H POINT DELETED  ,10X,3F12.5,10X,3F12.5)
      STML(L)=(AF*STML(L)+STML(J+1))/(AF+1.)
      XL(L)=(AF*XL(L)+XL(J+1))/(AF+1.)
      YL(L)=(AF*YL(L)+YL(J+1))/(AF+1.)
      ZL(L)=(AF*ZL(L)+ZL(J+1))/(AF+1.)
      UX(L)=(AF*UX(L)+UX(J+1))/(AF+1.)
      UY(L)=(AF*UY(L)+UY(J+1))/(AF+1.)
      UZ(L)=(AF*UZ(L)+UZ(J+1))/(AF+1.)
      GK1(L)=(AF*GK1(L)+GK1(J+1))/(AF+1.)
      GK2(L)=(AF*GK2(L)+GK2(J+1))/(AF+1.)
      H2(L)=(AF*H2(L)+H2(J+1))/(AF+1.)
      CP(L)=1.-(UX(L)**2+UY(L)**2+UZ(L)**2)/USQ
      UABS(L)=SQRT(1.-CP(L))
      AF=AF+1.
      GO TO 330
  320 AF=1.
      L=L+1
      K=J+1
      STML(L)=STML(K)
      XL(L)=XL(K)
      YL(L)=YL(K)
      ZL(L)=ZL(K)
      UX(L)=UX(K)
      UY(L)=UY(K)
```

```
      UZ(L)=UZ(K)
      GK1(L)=GK1(K)
      GK2(L)=GK2(K)
      H2(L)=H2(K)
      CP(L)=CP(K)
      UABS(L)=UABS(K)
      NQUAD(L)=NQUAD(K)
  330 CONTINUE
      L=L+1
      STML(L)=STML(JMAX)
      XL(L)=XL(JMAX)
      YL(L)=YL(JMAX)
      ZL(L)=ZL(JMAX)
      UX(L)=UX(JMAX)
      UY(L)=UY(JMAX)
      UZ(L)=UZ(JMAX)
      GK1(L)=GK1(JMAX)
      GK2(L)=GK2(JMAX)
      H2(L)=H2(JMAX)
      CP(L)=CP(JMAX)
      UABS(L)=UABS(JMAX)
      JMAX=L
      NQUAD(JMAX)=NQUAD(JMAX-1)
      NQUAD(JMIN)=NQUAD(JMIN+1)
      WRITE(6,51)
   51 FORMAT(4H0  I,6X,1HX,9X,1HY,
     19X,1HZ,09X,2HUX,8X,2HUY,8X,2HUZ,09X,
     22HCP, 8X,2HK1, 8X,2HK2, 8X,2HHZ,8X,2HSL,8X,1HV,9X,1HP)
      IF (AMACH .EQ. 0.) GOTO 1160
C *** COMPUTE COMPRESSIBILITY CORRECTION
      DO 1150 J=JMIN,JMAX
      USD = (UX(J)**2+UY(J)**2+UZ(J)**2)/VSQ
      USDA = USD
      SM = AMACH**2
      DO 1140 I=1,3
      R = (1.+.2*SM*(1.-USDA))
      IF (R .LT. .000001) R = .000001
      USDB = USD/R**2.5
      R = (1.+.2*SM*(1.-USDB))
      IF (R .LT. .000001) R = .000001
      USDC = USD/R**2.5
 1140 USDA = (USDC*USDA-USDB**2)/(USDC+USDA-2.*USDB)
      R = (1.+.2*SM*(1.-USDA))
      IF (R .LT. .000001) R = .000001
      R = R**1.25
      UX(J) = UX(J)/R
      UY(J) = UY(J)/R
      UZ(J) = UZ(J)/R
      UABS(J) = SQRT(USDA)
 1150 CP(J) = (R**2.8-1.)/(.7*SM)
 1150 CONTINUE
      K=0
      DO 53 I=JMIN,JMAX
      K=K+1
   53 WRITE(6,60) K,XL(I),YL(I),ZL(I),UX(I),UY(I),UZ(I),CP(I),
     1              GK1(I),GK2(I),H2(I),STML(I),UABS(I),NQUAD(I)
   60 FORMAT(1X,I3,3F10.5,1X,3F10.5,1X,6F10.5,I6)
    8 FORMAT(3F12.5)
      WRITE(17)  K, (XL(I),YL(I),ZL(I),NQUAD(I), I=JMIN,JMAX  )
C        IWRITE .LE. 0     --    WRITE SL,V,H2,K2
C        IWRITE .GE. 2     --    WRITE X,Y,Z,CP
C        IWRITE .EQ. 1     --    WRITE SL,V,H2,K2 AND X,Y,Z,CP
```

```
      IF (IWRITE.GT.1) GO TO 340
      WRITE(7)  K,  (STML(I),UABS(I),H2(I),GK2(I),I=JMIN,JMAX)
  340 IF (IWRITE.LT.1) GO TO 400
      WRITE(7)   K, (XL(I),YL(I),ZL(I),CP(I), I=JMIN,JMAX)
      GO TO 400
  300 WRITE(6,50)  NSP(LL)
      WRITE(6,65)
      GO TO 282
  400 CONTINUE
      GO TO 100
C     READ NEXT SET OF STREAMLINES
  450 WRITE(6,451)IS,NO
  451 FORMAT(14H TAPE 04 ERROR,2I4)
  550 ENDFILE 7
      REWIND 7
      ENDFILE 17
      REWIND 17
      REWIND 04
      STOP 7
      END
```

APPENDIX VIII - TRIAXIAL ELLIPSOID INPUT FILE

```
SAMPLE PROBLEM TRIAXIAL ELLIPSOID
280    5 150 150 150    3  .00001   0    0    0    0    0    0    0    0  .000 .000 .0
      1.00000       .00000       .00000   1    1    1    0       .00000
       .97861       .00000       .10286   1    2    1    0       .00000
       .90789       .00000       .20960   1    3    1    0       .00000
       .82360       .00000       .28359   1    4    1    0       .00000
       .71583       .00000       .34914   1    5    1    0       .00000
       .62478       .00000       .39040   1    6    1    0       .00000
       .52537       .00000       .42544   1    7    1    0       .00000
       .44721       .00000       .44721   1    8    1    0       .00000
       .37530       .00000       .46345   1    9    1    0       .00000
       .29822       .00000       .47725   1   10    1    0       .00000
       .23692       .00000       .48576   1   11    1    0       .00000
       .16957       .00000       .49275   1   12    1    0       .00000
       .11467       .00000       .49670   1   13    1    0       .00000
       .05248       .00000       .49931   1   14    1    0       .00000
       .00000       .00000       .50000   1   15    1    0       .00000
       .99875       .10000       .00000   2    1    1    0       .00000
       .97739       .10000       .10273   2    2    1    0       .00000
       .90676       .10000       .20934   2    3    1    0       .00000
       .82257       .10000       .28323   2    4    1    0       .00000
       .71494       .10000       .34870   2    5    1    0       .00000
       .62399       .10000       .38991   2    6    1    0       .00000
       .52471       .10000       .42490   2    7    1    0       .00000
       .44665       .10000       .44665   2    8    1    0       .00000
       .37483       .10000       .46287   2    9    1    0       .00000
       .29785       .10000       .47665   2   10    1    0       .00000
       .23663       .10000       .48516   2   11    1    0       .00000
       .16946       .10000       .49213   2   12    1    0       .00000
       .11453       .10000       .49608   2   13    1    0       .00000
       .05241       .10000       .49859   2   14    1    0       .00000
       .00000       .10000       .49937   2   15    1    0       .00000
       .99499       .20000       .00000   3    1    1    0       .00000
       .97371       .20000       .10234   3    2    1    0       .00000
       .90334       .20000       .20855   3    3    1    0       .00000
       .81947       .20000       .28217   3    4    1    0       .00000
       .71225       .20000       .34739   3    5    1    0       .00000
       .62164       .20000       .38845   3    6    1    0       .00000
       .52274       .20000       .42330   3    7    1    0       .00000
       .44497       .20000       .44497   3    8    1    0       .00000
       .37342       .20000       .46113   3    9    1    0       .00000
       .29672       .20000       .47486   3   10    1    0       .00000
       .23574       .20000       .48333   3   11    1    0       .00000
       .16892       .20000       .49028   3   12    1    0       .00000
       .11410       .20000       .49421   3   13    1    0       .00000
       .05222       .20000       .49581   3   14    1    0       .00000
       .00000       .20000       .49749   3   15    1    0       .00000
       .98869       .30000       .00000   4    1    1    0       .00000
       .96754       .30000       .10169   4    2    1    0       .00000
       .89762       .30000       .20723   4    3    1    0       .00000
       .81428       .30000       .28038   4    4    1    0       .00000
       .70774       .30000       .34519   4    5    1    0       .00000
       .61771       .30000       .38599   4    6    1    0       .00000
       .51943       .30000       .42052   4    7    1    0       .00000
       .44215       .30000       .44215   4    8    1    0       .00000
       .37105       .30000       .45821   4    9    1    0       .00000
       .29484       .30000       .47185   4   10    1    0       .00000
       .23424       .30000       .48027   4   11    1    0       .00000
       .16775       .30000       .48718   4   12    1    0       .00000
```

.11338	.30000	.49108	4	13	1	0	.00000
.05189	.30000	.49366	4	14	1	0	.00000
.00000	.30000	.49434	4	15	1	0	.00000
.97980	.40000	.00000	5	1	1	0	.00000
.95884	.40000	.10078	5	2	1	0	.00000
.88955	.40000	.20537	5	3	1	0	.00000
.80696	.40000	.27786	5	4	1	0	.00000
.70137	.40000	.34208	5	5	1	0	.00000
.61215	.40000	.38251	5	6	1	0	.00000
.51476	.40000	.41684	5	7	1	0	.00000
.43818	.40000	.43818	5	8	1	0	.00000
.36771	.40000	.45409	5	9	1	0	.00000
.29219	.40000	.46761	5	10	1	0	.00000
.23214	.40000	.47595	5	11	1	0	.00000
.16624	.40000	.48280	5	12	1	0	.00000
.11236	.40000	.48667	5	13	1	0	.00000
.05142	.40000	.48922	5	14	1	0	.00000
.00000	.40000	.48990	5	15	1	0	.00000
.97980	.40000	.00000	6	1	2	0	.00000
.95884	.40000	.10078	6	2	2	0	.00000
.88955	.40000	.20537	6	3	2	0	.00000
.80696	.40000	.27786	6	4	2	0	.00000
.70137	.40000	.34208	6	5	2	0	.00000
.61215	.40000	.38251	6	6	2	0	.00000
.51476	.40000	.41684	6	7	2	0	.00000
.43818	.40000	.43818	6	8	2	0	.00000
.36771	.40000	.45409	6	9	2	0	.00000
.29219	.40000	.46761	6	10	2	0	.00000
.23214	.40000	.47595	6	11	2	0	.00000
.16624	.40000	.48280	6	12	2	0	.00000
.11236	.40000	.48667	6	13	2	0	.00000
.05142	.40000	.48922	6	14	2	0	.00000
.00000	.40000	.48990	6	15	2	0	.00000
.96825	.50000	.00000	7	1	2	0	.00000
.94754	.50000	.09959	7	2	2	0	.00000
.87906	.50000	.20295	7	3	2	0	.00000
.79745	.50000	.27458	7	4	2	0	.00000
.69310	.50000	.33805	7	5	2	0	.00000
.60434	.50000	.37801	7	6	2	0	.00000
.50869	.50000	.41193	7	7	2	0	.00000
.43301	.50000	.43301	7	8	2	0	.00000
.36339	.50000	.44874	7	9	2	0	.00000
.28875	.50000	.46209	7	10	2	0	.00000
.22940	.50000	.47034	7	11	2	0	.00000
.16428	.50000	.47710	7	12	2	0	.00000
.11103	.50000	.48093	7	13	2	0	.00000
.05081	.50000	.48346	7	14	2	0	.00000
.00000	.50000	.48412	7	15	2	0	.00000
.95394	.60000	.00000	8	1	2	0	.00000
.93354	.60000	.09812	8	2	2	0	.00000
.86507	.60000	.19995	8	3	2	0	.00000
.78566	.60000	.27052	8	4	2	0	.00000
.68286	.60000	.33305	8	5	2	0	.00000
.59500	.60000	.37242	8	6	2	0	.00000
.50117	.60000	.40564	8	7	2	0	.00000
.42652	.60000	.42651	8	8	2	0	.00000
.35801	.60000	.44211	8	9	2	0	.00000
.28448	.60000	.45527	8	10	2	0	.00000
.22601	.60000	.46339	8	11	2	0	.00000
.16185	.60000	.47005	8	12	2	0	.00000
.10939	.60000	.47392	8	13	2	0	.00000

.05006	.60000	.47631	8	14	2	0	.00000
.00000	.60000	.47697	8	15	2	0	.00000
.93675	.70000	.00000	9	1	2	0	.00000
.91671	.70000	.09635	9	2	2	0	.00000
.85047	.70000	.19635	9	3	2	0	.00000
.77150	.70000	.26565	9	4	2	0	.00000
.67056	.70000	.32705	9	5	2	0	.00000
.58526	.70000	.36571	9	6	2	0	.00000
.49214	.70000	.39853	9	7	2	0	.00000
.41893	.70000	.41893	9	8	2	0	.00000
.35156	.70000	.43414	9	9	2	0	.00000
.27936	.70000	.44706	9	10	2	0	.00000
.22194	.70000	.45504	9	11	2	0	.00000
.15894	.70000	.46158	9	12	2	0	.00000
.10742	.70000	.46529	9	13	2	0	.00000
.04916	.70000	.46773	9	14	2	0	.00000
.00000	.70000	.46837	9	15	2	0	.00000
.91652	.80000	.00000	10	1	2	0	.00000
.89691	.80000	.09427	10	2	2	0	.00000
.83210	.80000	.19210	10	3	2	0	.00000
.75484	.80000	.25991	10	4	2	0	.00000
.65507	.80000	.31999	10	5	2	0	.00000
.57262	.80000	.35781	10	6	2	0	.00000
.48151	.80000	.38992	10	7	2	0	.00000
.40988	.80000	.40988	10	8	2	0	.00000
.34397	.80000	.42476	10	9	2	0	.00000
.27332	.80000	.43741	10	10	2	0	.00000
.21714	.80000	.44521	10	11	2	0	.00000
.15550	.80000	.45161	10	12	2	0	.00000
.10510	.80000	.45523	10	13	2	0	.00000
.04810	.80000	.45763	10	14	2	0	.00000
.00000	.80000	.45826	10	15	2	0	.00000
.91652	.80000	.00000	11	1	3	0	.00000
.89691	.90000	.09427	11	2	3	0	.00000
.83210	.80000	.19210	11	3	3	0	.00000
.75484	.80000	.25991	11	4	3	0	.00000
.65507	.80000	.31999	11	5	3	0	.00000
.57262	.80000	.35781	11	6	3	0	.00000
.48151	.60000	.38992	11	7	3	0	.00000
.40988	.80000	.40988	11	8	3	0	.00000
.34397	.80000	.42476	11	9	3	0	.00000
.27332	.80000	.43741	11	10	3	0	.00000
.21714	.80000	.44521	11	11	3	0	.00000
.15550	.80000	.45161	11	12	3	0	.00000
.10510	.80000	.45523	11	13	3	0	.00000
04810	.80000	.45763	11	14	3	0	.00000
.00000	.80000	.45826	11	15	3	0	.00000
.89303	.90000	.00000	12	1	3	0	.00000
.87393	.90000	.09185	12	2	3	0	.00000
.81077	.90000	.18718	12	3	3	0	.00000
.73550	.90000	.25325	12	4	3	0	.00000
.63926	.90000	.31179	12	5	3	0	.00000
.55794	.90000	.34854	12	6	3	0	.00000
.46917	.90000	.37993	12	7	3	0	.00000
.39937	.90000	.39937	12	8	3	0	.00000
.33515	.90000	.41388	12	9	3	0	.00000
.26632	.90000	.42620	12	10	3	0	.00000
.21158	90000	.43380	12	11	3	0	.00000
.15152	.90000	.44004	12	12	3	0	.00000
.10241	.90000	.44357	12	13	3	0	.00000
.04687	.90000	.44590	12	14	3	0	.00000

.00000	.90000	.44651	12	15	3	0	.00000
.86603	1.00000	.00000	13	1	3	0	.00000
.84750	1.00000	.08908	13	2	3	0	.00000
.78626	1.00000	.18152	13	3	3	0	.00000
.71326	1.00000	.24559	13	4	3	0	.00000
.61993	1.00000	.30236	13	5	3	0	.00000
.54107	1.00000	.33810	13	6	3	0	.00000
.45498	1.00000	.36844	13	7	3	0	.00000
.38730	1.00000	.38730	13	8	3	0	.00000
.32502	1.00000	.40136	13	9	3	0	.00000
.25826	1.00000	.41331	13	10	3	0	.00000
.20518	1.00000	.42068	13	11	3	0	.00000
.14694	1.00000	.42573	13	12	3	0	.00000
.09931	1.00000	.43016	13	13	3	0	.00000
.04545	1.00000	.43242	13	14	3	0	.00000
.00000	1.00000	.43301	13	15	3	0	.00000
.83516	1.10000	.00000	14	1	3	0	.00000
.81730	1.10000	.08590	14	2	3	0	.00000
.75824	1.10000	.17505	14	3	3	0	.00000
.68784	1.10000	.23684	14	4	3	0	.00000
.59784	1.10000	.29159	14	5	3	0	.00000
.52179	1.10000	.32605	14	6	3	0	.00000
.43877	1.10000	.35531	14	7	3	0	.00000
.37350	1.10000	.37350	14	8	3	0	.00000
.31343	1.10000	.38706	14	9	3	0	.00000
.24906	1.10000	.39858	14	10	3	0	.00000
.19787	1.10000	.40559	14	11	3	0	.00000
.14170	1.10000	.41153	14	12	3	0	.00000
.09577	1.10000	.41483	14	13	3	0	.00000
.04383	1.10000	.41701	14	14	3	0	.00000
.00000	1.10000	.41758	14	15	3	0	.00000
.80000	1.20000	.00000	15	1	3	0	.00000
.79289	1.20000	.08228	15	2	3	0	.00000
.72631	1.20000	.16768	15	3	3	0	.00000
.65988	1.20000	.22687	15	4	3	0	.00000
.57267	1.20000	.27931	15	5	3	0	.00000
.49982	1.20000	.31232	15	6	3	0	.00000
.42030	1.20000	.34035	15	7	3	0	.00000
.35777	1.20000	.35777	15	8	3	0	.00000
.30024	1.20000	.37076	15	9	3	0	.00000
.23957	1.20000	.38180	15	10	3	0	.00000
.18954	1.20000	.38861	15	11	3	0	.00000
.13573	1.20000	.39420	15	12	3	0	.00000
.09174	1.20000	.39736	15	13	3	0	.00000
.04198	1.20000	.39945	15	14	3	0	.00000
.00000	1.20000	.40000	15	15	3	0	.00000
.80000	1.20000	.00000	16	1	4	0	.00000
.79289	1.20000	.08228	16	2	4	0	.00000
.72631	1.20000	.16768	16	3	4	0	.00000
.65988	1.20000	.22687	16	4	4	0	.00000
.57267	1.20000	.27931	16	5	4	0	.00000
.49982	1.20000	.31232	16	6	4	0	.00000
.42030	1.20000	.34035	16	7	4	0	.00000
.35777	1.20000	.35777	16	8	4	0	.00000
.30024	1.20000	.37076	16	9	4	0	.00000
.23957	1.20000	.38180	16	10	4	0	.00000
.18954	1.20000	.38861	16	11	4	0	.00000
.13573	1.20000	.39420	16	12	4	0	.00000
.09174	1.20000	.39736	16	13	4	0	.00000
.04198	1.20000	.39945	16	14	4	0	.00000
.00000	1.20000	.40000	16	15	4	0	.00000

.75993	1.30000	.00000	17	1	4	0	.00000
.74368	1.30000	.07816	17	2	4	0	.00000
.68994	1.30000	.15928	17	3	4	0	.00000
.62588	1.30000	.21551	17	4	4	0	.00000
.54399	1.30000	.26532	17	5	4	0	.00000
.47479	1.30000	.29668	17	6	4	0	.00000
.39925	1.30000	.32330	17	7	4	0	.00000
.33985	1.30000	.33985	17	8	4	0	.00000
.28520	1.30000	.35219	17	9	4	0	.00000
.22663	1.30000	.36268	17	10	4	0	.00000
.18005	1.30000	.36915	17	11	4	0	.00000
.12894	1.30000	.37446	17	12	4	0	.00000
.08714	1.30000	.37746	17	13	4	0	.00000
.03988	1.30000	.37944	17	14	4	0	.00000
.00000	1.30000	.37997	17	15	4	0	.00000
.71414	1.40000	.00000	18	1	4	0	.00000
.69887	1.40000	.07345	18	2	4	0	.00000
.64836	1.40000	.14969	18	3	4	0	.00000
.58817	1.40000	.20252	18	4	4	0	.00000
.51121	1.40000	.24933	18	5	4	0	.00000
.44619	1.40000	.27880	18	6	4	0	.00000
.37519	1.40000	.30382	18	7	4	0	.00000
.31937	1.40000	.31937	18	8	4	0	.00000
.26902	1.40000	.33097	18	9	4	0	.00000
.21297	1.40000	.34082	18	10	4	0	.00000
.16920	1.40000	.34690	18	11	4	0	.00000
.12117	1.40000	.35189	18	12	4	0	.00000
.08189	1.40000	.35472	18	13	4	0	.00000
.03748	1.40000	.35658	18	14	4	0	.00000
.00000	1.40000	.35707	18	15	4	0	.00000
.66144	1.50000	.00000	19	1	4	0	.00000
.64729	1.50000	.06903	19	2	4	0	.00000
.60051	1.50000	.13864	19	3	4	0	.00000
.54476	1.50000	.18758	19	4	4	0	.00000
.47348	1.50000	.23093	19	5	4	0	.00000
.41325	1.50000	.25823	19	6	4	0	.00000
.34750	1.50000	.28140	19	7	4	0	.00000
.29580	1.50000	.29580	19	8	4	0	.00000
.24824	1.50000	.30654	19	9	4	0	.00000
.19725	1.50000	.31567	19	10	4	0	.00000
.15671	1.50000	.32130	19	11	4	0	.00000
.11222	1.50000	.32592	19	12	4	0	.00000
.07585	1.50000	.32854	19	13	4	0	.00000
.03471	1.50000	.33026	19	14	4	0	.00000
.00000	1.50000	.33072	19	15	4	0	.00000
.60000	1.60000	.00000	20	1	4	0	.00000
.58717	1.60000	.06171	20	2	4	0	.00000
.54473	1.60000	.12576	20	3	4	0	.00000
.49416	1.60000	.17015	20	4	4	0	.00000
.42950	1.60000	.20948	20	5	4	0	.00000
.37487	1.60000	.23424	20	6	4	0	.00000
.31522	1.60000	.25526	20	7	4	0	.00000
.26833	1.60000	.26833	20	8	4	0	.00000
.22518	1.60000	.27807	20	9	4	0	.00000
.17893	1.60000	.28635	20	10	4	0	.00000
.14215	1.60000	.29145	20	11	4	0	.00000
.10180	1.60000	.29565	20	12	4	0	.00000
.06890	1.60000	.29802	20	13	4	0	.00000
.03149	1.60000	.29959	20	14	4	0	.00000
.00000	1.60000	.30000	20	15	4	0	.00000
.60000	1.60000	.00000	21	1	5	0	.00000

.59717	1.60000	.06171	21	2	5	0	.00000
.54473	1.60000	.12576	21	3	5	0	.00000
.49416	1.60000	.17015	21	4	5	0	.00000
.42950	1.60000	.20948	21	5	5	0	.00000
.37487	1.60000	.23424	21	6	5	0	.00000
.31522	1.60000	.25526	21	7	5	0	.00000
.26833	1.60000	.26833	21	8	5	0	.00000
.22518	1.60000	.27807	21	9	5	0	.00000
.17893	1.60000	.28635	21	10	5	0	.00000
.14215	1.60000	.29146	21	11	5	0	.00000
.10180	1.60000	.29565	21	12	5	0	.00000
.06880	1.60000	.29802	21	13	5	0	.00000
.03149	1.60000	.29959	21	14	5	0	.00000
.00000	1.60000	.30000	21	15	5	0	.00000
.52678	1.70000	.00000	22	1	5	0	.00000
.51552	1.70000	.05418	22	2	5	0	.00000
.47826	1.70000	.11042	22	3	5	0	.00000
.43386	1.70000	.14939	22	4	5	0	.00000
.37709	1.70000	.18392	22	5	5	0	.00000
.32912	1.70000	.20566	22	6	5	0	.00000
.27676	1.70000	.22411	22	7	5	0	.00000
.23558	1.70000	.23558	22	8	5	0	.00000
.19770	1.70000	.24414	22	9	5	0	.00000
.15710	1.70000	.25141	22	10	5	0	.00000
.12481	1.70000	.25589	22	11	5	0	.00000
.08938	1.70000	.25957	22	12	5	0	.00000
.05041	1.70000	.26165	22	13	5	0	.00000
.02765	1.70000	.26303	22	14	5	0	.00000
.00000	1.70000	.26339	22	15	5	0	.00000
.43589	1.80000	.00000	23	1	5	0	.00000
42657	1.80000	.04483	23	2	5	0	.00000
39574	1.80000	.09136	23	3	5	0	.00000
.35900	1.80000	.12361	23	4	5	0	.00000
.31202	1.80000	.15218	23	5	5	0	.00000
.27233	1.80000	.17017	23	6	5	0	.00000
.22900	1.80000	.18544	23	7	5	0	.00000
.19494	1.80000	.19494	23	8	5	0	.00000
.16359	1.80000	.20201	23	9	5	0	.00000
.12999	1.80000	.20803	23	10	5	0	.00000
10327	1.80000	.21174	23	11	5	0	.00000
.07396	1.80000	.21479	23	12	5	0	.00000
.04996	1.80000	.21651	23	13	5	0	.00000
.02288	1.80000	.21764	23	14	5	0	.00000
00000	1.80000	.21794	23	15	5	0	.00000
.31225	1.90000	.00000	24	1	5	0	.00000
.30557	1.90000	.03212	24	2	5	0	.00000
.28349	1.90000	.06545	24	3	5	0	.00000
.25717	1.90000	.08855	24	4	5	0	.00000
.22352	1.90000	.10902	24	5	5	0	.00000
.19509	1.90000	.12190	24	6	5	0	.00000
.16405	1.90000	.13234	24	7	5	0	.00000
.13964	1.90000	.13954	24	8	5	0	.00000
.11719	1.90000	.14471	24	9	5	0	.00000
.09312	1.90000	.14902	24	10	5	0	.00000
.07398	1.90000	.15168	24	11	5	0	.00000
.05292	1.90000	.15395	24	12	5	0	.00000
.03581	1.90000	.15510	24	13	5	0	.00000
.01639	1.90000	15591	24	14	5	0	.00000
.00000	1.90000	.15612	24	15	5	0	.00000
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.00000	2.00000	.00000	25	2	5	0	.00000

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     .00000     2.00000     .00000  25   7   5   0       .00000
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     .00000     2.00000     .00000  25   9   5   0       .00000
     .00000     2.00000     .00000  25  10   5   0       .00000
     .00000     2.00000     .00000  25  11   5   0       .00000
     .00000     2.00000     .00000  25  12   5   0       .00000
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     .00000     2.00000     .00000  25  15   5   0       .00000

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     .00000     3.00000      .00000

<EOR>
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    1.00000     1.00000      .00000
    1.50000      .00000      .00000
<EOR>
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     1.0000       .0500       .0000   1

<EOR>

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APPENDIX IX – TRIAXIAL ELLIPSOID OUTPUT FILE

```
XYZ POTENTIAL FLOW PROGRAM SECTION 1, VERSION 4

SAMPLE PROBLEM TRIAXIAL ELLIPSOID

NO. OF QUADS.   = 280
NO. OF SECTIONS=    5
MAX. NO. OF ITERATIONS X FLOW 150  Y FLOW 150  Z FLOW 150
3 PLANES OF SYMMETRY
ONVERGENCE CRITERIA  .00001

   ISP =  0

IEDIT1 =  0
IEDIT3 =  0
IEDIT4 =  0
ITAPE  =  0

XCENTER =  .00
YCENTER =  .00
ZCENTER =  .00
```

M	X1	X2	X3	X4	XP	XN	A	C24
N	Y1	Y2	Y3	Y4	YP	YN	FL	C25
P	Z1	Z2	Z3	Z4	ZP	ZN	C21	C26
1	.10000E+01	.97861E+00	.97739E+00	.99875E+00	.96669E+00	.97898E+00	.10500E-01	-.12411E+00
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49969E-01	.12345E-01	.72568E-01	-.17850E+01
1	.00000E+00	.10286E+00	.10273E+00	.00000E+00	.51397E-01	.20357E+00	.52298E-02	.29580E-02
1	.99875E+00	.97739E+00	.97371E+00	.99499E+00	.93621E+00	.97836E+00	.10480E-01	-.17886E+01
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.37158E-01	.72630E-01	-.12417E+00
2	.00000E+00	.10273E+00	.10234E+00	.00000E+00	.51268E-01	.20343E+00	.52152E-02	-.20145E-01
2	.97861E+00	.90789E+00	.90676E+00	.97739E+00	.94266E+00	.83359E+00	.12797E-01	-.17719E+01
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49990E-01	.11049E-01	.81395E-01	-.11160E+00
3	.10286E+00	.20960E+00	.20934E+00	.10273E+00	.15613E+00	.55227E+00	.75324E-02	-.17488E-01
2	.97739E+00	.90676E+00	.90334E+00	.97371E+00	.94030E+00	.83317E+00	.12771E-01	-.11154E+00
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.33368E-01	.81672E-01	-.17755E+01
4	.10273E+00	.20934E+00	.20855E+00	.10234E+00	.15574E+00	.55200E+00	.75096E-02	-.49839E-02
3	.90789E+00	.82360E+00	.82257E+00	.90676E+00	.86521E+00	.65964E+00	.11209E-01	-.95484E-01
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49990E-01	.95106E-02	.75334E-01	-.74362E+00
5	.20960E+00	.28359E+00	.28323E+00	.20934E+00	.24644E+00	.75152E+00	.25735E-02	.12543E-02
3	.90676E+00	.82257E+00	.81947E+00	.90334E+00	.86304E+00	.65939E+00	.11185E-01	-.74521E+00
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.28614E-01	.75703E-01	-.95755E-01
6	.20934E+00	.28323E+00	.28217E+00	.20855E+00	.24582E+00	.75125E+00	.25672E-02	-.28143E-01
4	.82360E+00	.71563E+00	.71494E+00	.82257E+00	.76924E+00	.51966E+00	.12606E-01	-.74292E+00
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49989E-01	.84797E-02	.80694E-01	-.84505E-01
7	.28359E+00	.34914E+00	.34870E+00	.28323E+00	.31617E+00	.85433E+00	.31622E-02	-.94470E-02
4	.82257E+00	.71494E+00	.71225E+00	.81947E+00	.76731E+00	.51952E+00	.12578E-01	-.84442E-01
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.25380E-01	.81066E-01	-.74470E+00
8	.28323E+00	.34870E+00	.34739E+00	.28217E+00	.31537E+00	.85408E+00	.31536E-02	-.73090E-04
5	.71583E+00	.62478E+00	.62399E+00	.71494E+00	.66989E+00	.41272E+00	.99910E-02	-.76789E-01
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49991E-01	.77244E-02	.70882E-01	-.42378E+00
9	.34914E+00	.39040E+00	.38991E+00	.34870E+00	.36954E+00	.91082E+00	.12491E-02	.84063E-03
5	.71494E+00	.62399E+00	.62164E+00	.71225E+00	.66821E+00	.41262E+00	.99691E-02	-.42496E+00
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.23084E-01	.71213E-01	-.76925E-01
10	.34870E+00	.38991E+00	.38849E+00	.34739E+00	.36861E+00	.91061E+00	.12471E-02	-.15018E-01
6	.62478E+00	.52537E+00	.52471E+00	.62399E+00	.57471E+00	.33241E+00	.10534E-01	-.42372E+00
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49989E-01	.72964E-02	.72808E-01	-.71978E-01
11	.39040E+00	.42544E+00	.42490E+00	.38991E+00	.40766E+00	.94311E+00	.13556E-02	-.39695E-02
6	.62399E+00	.52471E+00	.52274E+00	.62164E+00	.57327E+00	.33229E+00	.10509E-01	-.71955E-01
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.21690E-01	.73066E-01	-.42500E+00
12	.38991E+00	.42490E+00	.42330E+00	.38849E+00	.40664E+00	.94293E+00	.13521E-02	.22457E-03
7	.52537E+00	.44721E+00	.44665E+00	.52471E+00	.46596E+00	.26836E+00	.81086E-02	-.66911E-01
1	.00000E+00	[illegible]	.10000E+00	.10000E+00	[illegible]	.59469E-02	.64511E-01	-.32082E+00
13	.42544E+00	.44721E+00	[illegible]	[illegible]	.43605E+00	.96329E+00	.70022E-03	.17961E-02

N P	X1 Y1 Z1	Y2 Z2	Z3	Y4 Z4	YP ZP	YN ZN	FL C21	C25 C26
7	.52471E+00	.44665E+00	.44497E+00	.52279E+00	.46477E+00	.26835E+00	.80900E-02	-.32183E+00
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.20727E-01	.64733E-01	-.68965E-01
14	.42490E+00	.44665E+00	.44497E+00	.42330E+00	.43496E+00	.96310E+00	.69804E-03	-.85764E-02
8	.44721E+00	.37530E+00	.37463E+00	.44665E+00	.41100E+00	.22024E+00	.73677E-02	-.32082E+00
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49990E-01	.67038E-02	.62218E-01	-.67036E-01
15	.44721E+00	.46345E+00	.46287E+00	.44665E+00	.45505E+00	.97541E+00	.60291E-03	-.24607E-02
8	.44665E+00	.37463E+00	.37342E+00	.44497E+00	.40997E+00	.22026E+00	.73505E-02	-.67020E-01
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.20108E-01	.62395E-01	-.32189E+00
16	.44665E+00	.46287E+00	.46113E+00	.44497E+00	.45391E+00	.97523E+00	.60228E-03	.94007E-03
9	.37530E+00	.29822E+00	.29785E+00	.37463E+00	.33655E+00	.17622E+00	.78256E-02	-.65399E-01
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49989E-01	.65574E-02	.63586E-01	-.27940E+00
17	.46345E+00	.47725E+00	.47665E+00	.46287E+00	.47006E+00	.98453E+00	.59108E-03	.35907E-03
9	.37483E+00	.29785E+00	.29672E+00	.37342E+00	.33571E+00	.17617E+00	.78076E-02	-.27971E+00
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.19635E-01	.63728E-01	-.65426E-01
18	.46287E+00	.47665E+00	.47466E+00	.46113E+00	.46868E+00	.98416E+00	.58967E-03	-.52681E-02
10	.29822E+00	.23692E+00	.23663E+00	.29785E+00	.26741E+00	.13759E+00	.61850E-02	-.27942E+00
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49989E-01	.64023E-02	.58856E-01	-.64671E-01
19	.47725E+00	.48576E+00	.48516E+00	.47665E+00	.48121E+00	.99047E+00	.42796E-03	-.31447E-02
10	.29785E+00	.23663E+00	.23574E+00	.29672E+00	.26674E+00	.13760E+00	.61699E-02	-.64660E-01
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.19331E-01	.58954E-01	-.27975E+00
20	.47665E+00	.48516E+00	.48333E+00	.47466E+00	.48000E+00	.99030E+00	.42729E-03	-.61924E-03
11	.23692E+00	.16967E+00	.16946E+00	.23663E+00	.20317E+00	.10330E+00	.67573E-02	-.63885E-01
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49990E-01	.63313E-02	.60397E-01	-.25888E+00
21	.48576E+00	.49275E+00	.49213E+00	.48516E+00	.48895E+00	.99463E+00	.45426E-03	-.13246E-02
11	.23663E+00	.16946E+00	.16862E+00	.23574E+00	.20266E+00	.10324E+00	.67418E-02	-.25913E+00
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.19106E-01	.60466E-01	-.63901E-01
22	.48516E+00	.49213E+00	.49028E+00	.48333E+00	.48773E+00	.99447E+00	.45363E-03	-.38368E-02
12	.16967E+00	.11467E+00	.11453E+00	.16946E+00	.14208E+00	.71678E-01	.55108E-02	-.25890E+00
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49989E-01	.63130E-02	.57122E-01	-.63172E-01
23	.49275E+00	.49670E+00	.49605E+00	.49213E+00	.49442E+00	.99741E+00	.35406E-03	-.15840E-02
12	.16946E+00	.11453E+00	.11410E+00	.16862E+00	.14173E+00	.71667E-01	.54976E-02	-.63170E-01
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.18943E-01	.57160E-01	-.25915E+00
24	.49213E+00	.49605E+00	.49421E+00	.49028E+00	.49318E+00	.99725E+00	.35332E-03	-.79794E-03
13	.11467E+00	.52470E-01	.52410E-01	.11453E+00	.83523E-01	.41954E-01	.62211E-02	-.63181E-01
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49991E-01	.62428E-02	.56907E-01	-.25222E+00
25	.49670E+00	.49931E+00	.49867E+00	.49605E+00	.49769E+00	.99910E+00	.40223E-03	.70397E-03
13	.11453E+00	.52410E-01	.52220E-01	.11410E+00	.83315E-01	.41972E-01	.62066E-02	-.25358E+00
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.18875E-01	.56913E-01	-.63182E-01
26	.49605E+00	.49867E+00	.49681E+00	.49421E+00	.49645E+00	.99694E+00	.40212E-03	-.11849E-02

N P	X1 Y1 Z1	X2 Y2 Z2	X3 Y3 Z3	X4 Y4 Z4	XP YP ZP	XN YN ZN	FL C21	C24 C25 C26
14	.52480E-01	.00000E+00	.00000E+00	.52410E-01	.26222E-01	.13060E-01	.52450E-02	-.25223E+00
1	.00000E+00	.00000E+00	.10000E+00	.10000E+00	.49969E-01	.62572E-02	.56467E-01	-.62811E-01
27	.49931E+00	.50000E+00	.49937E+00	.49869E+00	.49934E+00	.99990E+00	.33126E-03	.15965E-02
14	.52410E-01	.00000E+00	.00000E+00	.52229E-01	.26158E-01	.12995E-01	.52329E-02	-.62812E-01
2	.10000E+00	.10000E+00	.20000E+00	.20000E+00	.14997E+00	.18816E-01	.56454E-01	-.25358E+00
28	.49869E+00	.49937E+00	.49749E+00	.49661E+00	.49809E+00	.99974E+00	.33063E-03	.19808E-03
1	.99499E+00	.97371E+00	.96754E+00	.98869E+00	.98124E+00	.97716E+00	.10440E-01	-.12683E+00
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.62193E-01	.72619E-01	-.17958E+01
29	.00000E+00	.10234E+00	.10169E+00	.00000E+00	.51008E-01	.20321E+00	.51918E-02	.12965E-01
1	.98869E+00	.96754E+00	.95804E+00	.97960E+00	.97372E+00	.97529E+00	.10379E-01	-.18064E+01
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34993E+00	.87549E-01	.72539E-01	-.12715E+00
30	.00000E+00	.10169E+00	.10078E+00	.00000E+00	.50618E-01	.20264E+00	.51480E-02	-.48494E-01
2	.97371E+00	.90334E+00	.89762E+00	.96754E+00	.93556E+00	.83234E+00	.12720E-01	-.17812E+01
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.55815E-01	.81841E-01	-.11485E+00
31	.10234E+00	.20855E+00	.20723E+00	.10169E+00	.15495E+00	.55145E+00	.74677E-02	-.87983E-01
2	.96754E+00	.89762E+00	.88955E+00	.95804E+00	.92839E+00	.83107E+00	.12641E-01	-.11365E+00
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.78560E-01	.81902E-01	-.17928E+01
32	.10169E+00	.20723E+00	.20537E+00	.10078E+00	.15377E+00	.55058E+00	.73965E-02	-.11139E-01
3	.90334E+00	.81947E+00	.81428E+00	.89762E+00	.85868E+00	.65892E+00	.11137E-01	-.97736E-01
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.47902E-01	.75979E-01	-.74942E+00
33	.20855E+00	.28217E+00	.28038E+00	.20723E+00	.24458E+00	.75069E+00	.25610E-02	.10285E-01
3	.89762E+00	.81428E+00	.80676E+00	.88955E+00	.85211E+00	.65816E+00	.11064E-01	-.75390E+00
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.67468E-01	.76171E-01	-.99216E-01
34	.20723E+00	.28038E+00	.27706E+00	.20537E+00	.24271E+00	.74965E+00	.25426E-02	-.65154E-01
4	.81947E+00	.71225E+00	.70774E+00	.81428E+00	.76344E+00	.51923E+00	.12521E-01	-.74763E+00
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.42573E-01	.81325E-01	-.87945E-01
35	.28217E+00	.34759E+00	.34519E+00	.28038E+00	.31378E+00	.85357E+00	.31434E-02	-.46661E-01
4	.81428E+00	.70774E+00	.70137E+00	.80676E+00	.75759E+00	.51874E+00	.12437E-01	-.87042E-01
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.60024E-01	.81479E-01	-.75409E+00
36	.28038E+00	.34519E+00	.34208E+00	.27706E+00	.31138E+00	.85262E+00	.31174E-02	-.64145E-03
5	.71225E+00	.62164E+00	.61771E+00	.70774E+00	.66484E+00	.41245E+00	.99235E-02	-.79895E-01
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.38758E-01	.71463E-01	-.42769E+00
37	.34759E+00	.38845E+00	.38599E+00	.34519E+00	.36676E+00	.91016E+00	.12507E-02	.70682E-02
5	.70774E+00	.61771E+00	.61215E+00	.70137E+00	.65975E+00	.41214E+00	.98545E-02	-.43003E+00
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.54728E-01	.71642E-01	-.80645E-01
38	.34519E+00	.38599E+00	.38251E+00	.34208E+00	.36394E+00	.90947E+00	.12416E-02	-.34708E-01
6	.62164E+00	.52274E+00	.51943E+00	.61771E+00	.57038E+00	.33212E+00	.10460E-01	-.42716E+00
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.36365E-01	.73263E-01	-.75178E-01
39	.38845E+00	[illegible]	[illegible]	[illegible]	.40459E+00	.94254E+00	.13545E-02	-.21719E-01

N P	Y1 Z1	Y2 Z2	Y3 Z3	Y4 Z4	YP ZP	YN ZN	FL C21	C25 C26
6	.61771E+00	.51943E+00	.51476E+00	.61215E+00	.56602E+00	.33195E+00	.10367E-01	-.74777E-01
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.51368E-01	.73400E-01	-.43056E+00
40	.38599E+00	.42062E+00	.41664E+00	.36251E+00	.40149E+00	.94190E+00	.13452E-02	.33122E-02
7	.52274E+00	.44497E+00	.44215E+00	.51943E+00	.46232E+00	.26823E+00	.80526E-02	-.70941E-01
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.34755E-01	.64904E-01	-.32329E+00
41	.42330E+00	.44497E+00	.44215E+00	.42062E+00	.43276E+00	.96273E+00	.70054E-03	.40087E-02
7	.51943E+00	.44215E+00	.43818E+00	.51476E+00	.47863E+00	.26808E+00	.79956E-02	-.32575E+00
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.46948E-01	.65019E-01	-.71303E-01
42	.42062E+00	.44215E+00	.43818E+00	.41664E+00	.42945E+00	.96215E+00	.69684E-03	-.20919E-01
8	.44497E+00	.37342E+00	.37105E+00	.44215E+00	.40790E+00	.22019E+00	.73163E-02	-.32311E+00
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.33740E-01	.62529E-01	-.69037E-01
43	.44497E+00	.46113E+00	.45821E+00	.44215E+00	.45162E+00	.97487E+00	.60426E-03	-.12483E-01
8	.44215E+00	.37105E+00	.36771E+00	.43818E+00	.40478E+00	.22003E+00	.72649E-02	-.68865E-01
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34993E+00	.47520E-01	.62618E-01	-.32599E+00
44	.44215E+00	.45821E+00	.45409E+00	.43818E+00	.44816E+00	.97434E+00	.60090E-03	.98076E-03
9	.37342E+00	.29672E+00	.29464E+00	.37105E+00	.33401E+00	.17610E+00	.77712E-02	-.67399E-01
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.32960E-01	.63816E-01	-.28124E+00
45	.46113E+00	.47486E+00	.47165E+00	.45821E+00	.46651E+00	.98382E+00	.59256E-03	.28884E-02
9	.37105E+00	.29464E+00	.29219E+00	.36771E+00	.33145E+00	.17601E+00	.77154E-02	-.28330E+00
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.46439E-01	.63850E-01	-.67558E-01
46	.45821E+00	.47165E+00	.46761E+00	.45409E+00	.46294E+00	.98329E+00	.58930E-03	-.12965E-01
10	.29672E+00	.23574E+00	.23424E+00	.29464E+00	.26539E+00	.13753E+00	.61406E-02	-.28118E+00
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.32396E-01	.59019E-01	-.66344E-01
47	.47486E+00	.48333E+00	.48027E+00	.47165E+00	.47758E+00	.98997E+00	.43046E-03	-.75106E-02
10	.29484E+00	.23424E+00	.23214E+00	.29219E+00	.26335E+00	.13745E+00	.60968E-02	-.66271E-01
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.45651E-01	.59051E-01	-.28340E+00
48	.47165E+00	.48027E+00	.47595E+00	.46761E+00	.47392E+00	.98946E+00	.42851E-03	.54621E-03
11	.23574E+00	.16862E+00	.16775E+00	.23424E+00	.20164E+00	.10328E+00	.67098E-02	-.65772E-01
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.31977E-01	.60493E-01	-.26176E+00
49	.48333E+00	.49028E+00	.48718E+00	.48027E+00	.48527E+00	.99414E+00	.45931E-03	.28002E-02
11	.23424E+00	.16775E+00	.16624E+00	.23214E+00	.20009E+00	.10327E+00	.66619E-02	-.26399E+00
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34993E+00	.45129E-01	.60478E-01	-.65822E-01
50	.48027E+00	.48718E+00	.48280E+00	.47595E+00	.48155E+00	.99363E+00	.45697E-03	-.72947E-02
12	.16862E+00	.11410E+00	.11338E+00	.16775E+00	.14101E+00	.71555E-01	.54713E-02	-.26176E+00
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.31713E-01	.57171E-01	-.65073E-01
51	.49028E+00	.49421E+00	.49104E+00	.48718E+00	.49069E+00	.99693E+00	.35894E-03	-.26159E-02
12	.16775E+00	.11338E+00	.11236E+00	.16624E+00	.13993E+00	.71523E-01	.54319E-02	-.65058E-01
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.44725E-01	.57158E-01	-.26404E+00
52	.48718E+00	.49109E+00	.48667E+00	.48280E+00	.48694E+00	.99644E+00	.35777E-03	.12042E-02

N P	Y1 Z1	Y2 Z2	Y3 Z3	Y4 Z4	YP ZP	YN ZN	FL C21	C25 C26
13	.11410E+00	.52220E-01	.51890E-01	.11350E+00	.82698E-01	.41930E-01	.61770E-02	-.64578E-01
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.31601E-01	.56886E-01	-.25395E+00
53	.49421E+00	.49681E+00	.47360E+00	.49108E+00	.49374E+00	.99862E+00	.40331E-03	.60019E-03
13	.11338E+00	.51890E-01	.51420E-01	.11236E+00	.82263E-01	.41823E-01	.61329E-02	-.25413E+00
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34993E+00	.44512E-01	.56827E-01	-.64582E-01
54	.49108E+00	.49366E+00	.46922E+00	.48867E+00	.49016E+00	.99813E+00	.40084E-03	-.17060E-02
14	.52220E-01	.00000E+00	.00000E+00	.51890E-01	.26028E-01	.13056E-01	.52085E-02	-.25396E+00
3	.20000E+00	.20000E+00	.30000E+00	.30000E+00	.24995E+00	.31518E-01	.56420E-01	-.64452E-01
55	.49681E+00	.49749E+00	.47434E+00	.49306E+00	.49558E+00	.99942E+00	.33300E-03	-.14554E-02
14	.51890E-01	.00000E+00	.00000E+00	.51420E-01	.25828E-01	.13150E-01	.51710E-02	-.64447E-01
4	.30000E+00	.30000E+00	.40000E+00	.40000E+00	.34992E+00	.44404E-01	.56362E-01	-.25414E+00
56	.49366E+00	.49434E+00	.48990E+00	.48922E+00	.49178E+00	.99893E+00	.33151E-03	.53201E-03

M N P	X1 Y1 Z1	X2 Y2 Z2	X3 Y3 Z3	X4 Y4 Z4	XP YP ZP	XN YN ZN	A FL CZ1	CZ4 CZ5 CZ6
1	.97980E+00	.95884E+00	.94754E+00	.96825E+00	.96362E+00	.97273E+00	.10298E-01	-.13315E+00
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.11344E+00	.72366E-01	-.18220E+01
57	.00000E+00	.10078E+00	.99590E-01	.00000E+00	.50093E-01	.20229E+00	.51058E-02	.25252E-01
1	.96825E+00	.94754E+00	.93354E+00	.95394E+00	.95084E+00	.96941E+00	.10196E-01	-.18411E+01
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.14006E+00	.72167E-01	-.13398E+00
58	.00000E+00	.99590E-01	.98120E-01	.00000E+00	.49428E-01	.20157E+00	.50318E-02	-.79263E-01
2	.95884E+00	.88955E+00	.87906E+00	.94754E+00	.91876E+00	.82930E+00	.12536E-01	-.18037E+01
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.10190E+00	.81859E-01	-.12337E+00
59	.10078E+00	.20537E+00	.20295E+00	.99590E-01	.15217E+00	.54943E+00	.73177E-02	-.16165E+00
2	.94754E+00	.87906E+00	.86607E+00	.93354E+00	.90657E+00	.82700E+00	.12403E-01	-.11943E+00
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.12587E+00	.81715E-01	-.18266E+01
60	.99590E-01	.20295E+00	.19995E+00	.98120E-01	.15016E+00	.54793E+00	.71985E-02	-.17945E-01
3	.88955E+00	.80696E+00	.79745E+00	.87906E+00	.84326E+00	.65712E+00	.10965E-01	-.10319E+00
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.87571E-01	.76277E-01	-.76373E+00
61	.20537E+00	.27786E+00	.27458E+00	.20295E+00	.24019E+00	.74868E+00	.25312E-02	.20143E-01
3	.87906E+00	.79745E+00	.78566E+00	.86607E+00	.83208E+00	.65576E+00	.10842E-01	-.77007E+00
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.10826E+00	.76304E-01	-.10710E+00
62	.20295E+00	.27458E+00	.27032E+00	.19995E+00	.23700E+00	.74716E+00	.24969E-02	-.10646E+00
4	.80696E+00	.70137E+00	.69310E+00	.79745E+00	.74973E+00	.51807E+00	.12323E-01	-.75918E+00
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.77847E-01	.81527E-01	-.94748E-01
63	.27786E+00	.34208E+00	.33805E+00	.27458E+00	.30815E+00	.85179E+00	.30969E-02	-.86518E-01
4	.79745E+00	.69310E+00	.68286E+00	.78566E+00	.73978E+00	.51726E+00	.12179E-01	-.91774E-01
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.96319E-01	.81470E-01	-.77177E+00
64	.27458E+00	.33805E+00	.33305E+00	.27032E+00	.30406E+00	.85039E+00	.30531E-02	.89605E-03
5	.70137E+00	.61215E+00	.60494E+00	.69310E+00	.65290E+00	.41176E+00	.97617E-02	-.84372E-01
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.70847E-01	.71746E-01	-.43567E+00
65	.34208E+00	.38251E+00	.37801E+00	.33805E+00	.36017E+00	.90854E+00	.12426E-02	.13917E-01
5	.69310E+00	.60494E+00	.59600E+00	.68286E+00	.64424E+00	.41124E+00	.96449E-02	-.44000E+00
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.87760E-01	.71780E-01	-.86404E-01
66	.33805E+00	.37801E+00	.37242E+00	.33305E+00	.35539E+00	.90729E+00	.12286E-02	-.57336E-01
6	.61215E+00	.51476E+00	.50869E+00	.60494E+00	.56014E+00	.33168E+00	.10288E-01	-.43394E+00
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.66554E-01	.73433E-01	-.80464E-01
67	.38251E+00	.41684E+00	.41193E+00	.37801E+00	.39733E+00	.94104E+00	.13438E-02	-.39939E-01
6	.60494E+00	.50869E+00	.50117E+00	.59600E+00	.55271E+00	.33125E+00	.10164E-01	-.79258E-01
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.82469E-01	.73387E-01	-.44135E+00
68	.37801E+00	.41193E+00	.40564E+00	.37242E+00	.39206E+00	.93993E+00	.13281E-02	.38303E-02
7	.51476E+00	[illegible]	.43301E+00	.50869E+00	.47367E+00	.26764E+00	.79189E-02	-.75409E-01
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.63612E-01	.65066E-01	-.32925E+00
69	.41684E+00	[illegible]	.43301E+00	.41193E+00	.42500E+00	.96136E+00	.70198E-03	.73563E-02

N P	Y1 Z1	Y2 Z2	Y3 Z3	Y4 Z4	YF ZF	YN ZN	FL C21	C25 C26
7	.50869E+00	.43301E+00	.42602E+00	.50117E+00	.40738E+00	.26752E+00	.78217E-02	-.33211E+00
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54987E+00	.78712E-01	.65098E-01	-.76371E-01
70	.41193E+00	.43301E+00	.42601E+00	.40564E+00	.41936E+00	.96033E+00	.69443E-03	-.33856E-01
8	.43818E+00	.36771E+00	.36336E+00	.43301E+00	.40057E+00	.21987E+00	.71951E-02	-.32860E+00
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.61741E-01	.62663E-01	-.73674E-01
71	.43818E+00	.45409E+00	.44874E+00	.43301E+00	.44351E+00	.97357E+00	.60669E-03	-.24103E-01
8	.43301E+00	.36338E+00	.35801E+00	.42662E+00	.37526E+00	.21971E+00	.71069E-02	-.73069E-01
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.76367E-01	.62665E-01	-.33278E+00
72	.43301E+00	.44874E+00	.44211E+00	.42661E+00	.43763E+00	.97257E+00	.60101E-03	.36245E-02
9	.36771E+00	.29219E+00	.28875E+00	.36338E+00	.32801E+00	.17583E+00	.76406E-02	-.71294E-01
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.60318E-01	.63833E-01	-.28574E+00
73	.45409E+00	.46761E+00	.46209E+00	.44874E+00	.45814E+00	.98257E+00	.59331E-03	.46377E-02
9	.36338E+00	.28875E+00	.28448E+00	.35801E+00	.32366E+00	.17564E+00	.75466E-02	-.28891E+00
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.74564E-01	.63773E-01	-.71735E-01
74	.44874E+00	.46209E+00	.45527E+00	.44211E+00	.45206E+00	.98163E+00	.58789E-03	-.21403E-01
10	.29219E+00	.23214E+00	.22940E+00	.28875E+00	.26062E+00	.13738E+00	.60380E-02	-.28550E+00
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.59315E-01	.59055E-01	-.70256E-01
75	.46761E+00	.47595E+00	.47034E+00	.46209E+00	.46900E+00	.98874E+00	.43453E-03	-.14267E-01
10	.28875E+00	.22940E+00	.22601E+00	.28448E+00	.25716E+00	.13725E+00	.59636E-02	-.70017E-01
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.73327E-01	.59030E-01	-.28915E+00
76	.46209E+00	.47034E+00	.46339E+00	.45527E+00	.46278E+00	.98782E+00	.43101E-03	.75220E-03
11	.23214E+00	.16624E+00	.16428E+00	.22940E+00	.19602E+00	.10314E+00	.65976E-02	-.69391E-01
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.58629E-01	.60428E-01	-.26535E+00
77	.47595E+00	.48260E+00	.47710E+00	.47034E+00	.47655E+00	.99294E+00	.46106E-03	.26133E-02
11	.22940E+00	.16428E+00	.16165E+00	.22601E+00	.19539E+00	.10298E+00	.65159E-02	-.26783E+00
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.72506E-01	.60339E-01	-.69533E-01
78	.47034E+00	.47710E+00	.47005E+00	.46339E+00	.47023E+00	.99204E+00	.45728E-03	-.11550E-01
12	.16624E+00	.11236E+00	.11103E+00	.16428E+00	.13848E+00	.71569E-01	.53794E-02	-.26527E+00
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.56165E-01	.57122E-01	-.68896E-01
79	.48280E+00	.48667E+00	.48093E+00	.47710E+00	.48188E+00	.99574E+00	.36353E-03	-.74949E-02
12	.16428E+00	.11103E+00	.10939E+00	.16165E+00	.13664E+00	.71524E-01	.53129E-02	-.68825E-01
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.71929E-01	.57061E-01	-.26790E+00
80	.47710E+00	.48093E+00	.47362E+00	.47005E+00	.47548E+00	.99484E+00	.36077E-03	-.82686E-04
13	.11236E+00	.51420E-01	.50810E-01	.11103E+00	.81406E-01	.41821E-01	.60735E-02	-.69052E-01
6	.40000E+00	.40000E+00	.50000E+00	.50000E+00	.44990E+00	.57862E-01	.56734E-01	-.25738E+00
81	.48667E+00	.48922E+00	.48346E+00	.48093E+00	.48507E+00	.99745E+00	.41059E-03	.40314E-02
13	.11103E+00	.50810E-01	.50069E-01	.10939E+00	.80324E-01	.41846E-01	.59981E-02	-.26136E+00
7	.50000E+00	.50000E+00	.60000E+00	.60000E+00	.54988E+00	.71667E-01	.58606E-01	-.69061E-01
82	.48093E+00	.48347E+00	.47631E+00	.47362E+00	.47804E+00	.99655E+00	.40761E-03	-.42261E-02

N P	X1 Y1 Z1	Y2 Z2	Y3 Z3	Y4 Z4	YP ZP	YN ZN	FL C21	C25 C26
14 6 83	.51420E-01 .40000E+00 .48922E+00	.00000E+00 .40000E+00 .48990E+00	.00000E+00 .50000E+00 .46412E+00	.50810E-01 .50000E+00 .46346E+00	.25598E-01 .44990E+00 .46608E+00	.13084E-01 .57665E-01 .99825E+00	.51205E-02 .56281E-01 .34136E-03	-.25737E+00 -.66652E-01 .11592E-02
14 7 84	.50810E-01 .50000E+00 .46346E+00	.00000E+00 .50000E+00 .46412E+00	.00000E+00 .60000E+00 .47697E+00	.00000E-01 .60000E+00 .47651E+00	.25218E-01 .54988E+00 .46022E+00	.13052E-01 .71393E-01 .99736E+00	.50568E-02 .56178E-01 .33958E-03	-.68650E-01 -.26138E+00 .87972E-03
1 8 85	.95394E+00 .60000E+00 .00000E+00	.93354E+00 .60000E+00 .98120E-01	.91671E+00 .70000E+00 .96350E-01	.93675E+00 .70000E+00 .00000E+00	.93526E+00 .64985E+00 .46619E-01	.96521E+00 .16759E+00 .20072E+00	.10071E-01 .71884E-01 .49646E-02	-.14281E+00 -.18657E+01 .37208E-01
1 9 86	.93675E+00 .70000E+00 .00000E+00	.91671E+00 .70000E+00 .96350E-01	.83691E+00 .80000E+00 .94270E-01	.91652E+00 .80000E+00 .00000E+00	.91676E+00 .74982E+00 .47657E-01	.96003E+00 .19613E+00 .19969E+00	.99241E-02 .71544E-01 .48575E-02	-.18932E+01 -.14444E+00 -.11331E+00
2 8 87	.93354E+00 .60000E+00 .98120E-01	.86607E+00 .60000E+00 .19995E+00	.85047E+00 .70000E+00 .19635E+00	.91671E+00 .70000E+00 .96350E-01	.89172E+00 .64985E+00 .14770E+00	.82413E+00 .15071E+00 .54598E+00	.12241E-01 .81470E-01 .70742E-02	-.18408E+01 -.13766E+00 -.24571E+00
2 9 88	.91671E+00 .70000E+00 .96350E-01	.85047E+00 .70000E+00 .19635E+00	.83210E+00 .80000E+00 .19210E+00	.89691E+00 .80000E+00 .94270E-01	.87408E+00 .74982E+00 .14477E+00	.82057E+00 .17604E+00 .54357E+00	.12049E-01 .81128E-01 .68995E-02	-.12875E+00 -.18773E+01 -.24918E-01
3 8 89	.86607E+00 .60000E+00 .19995E+00	.78566E+00 .60000E+00 .27052E+00	.77150E+00 .70000E+00 .26565E+00	.85047E+00 .70000E+00 .19635E+00	.81845E+00 .64985E+00 .23312E+00	.65404E+00 .12904E+00 .74527E+00	.10692E-01 .76256E-01 .24818E-02	-.11207E+00 -.78718E+00 .30955E-01
3 9 90	.85047E+00 .70000E+00 .19635E+00	.77150E+00 .70000E+00 .26565E+00	.75484E+00 .80000E+00 .25991E+00	.83210E+00 .80000E+00 .19210E+00	.80226E+00 .74982E+00 .22851E+00	.65193E+00 .15219E+00 .74285E+00	.10514E-01 .76133E-01 .24357E-02	-.79534E+00 -.12027E+00 -.15595E+00
4 8 91	.78566E+00 .60000E+00 .27052E+00	.68286E+00 .60000E+00 .33305E+00	.67056E+00 .70000E+00 .32705E+00	.77150E+00 .70000E+00 .26565E+00	.72767E+00 .64985E+00 .29908E+00	.51621E+00 .11540E+00 .84865E+00	.12002E-01 .81308E-01 .30191E-02	-.77776E+00 -.10595E+00 -.13112E+00
4 9 92	.77150E+00 .70000E+00 .26565E+00	.67056E+00 .70000E+00 .32705E+00	.65607E+00 .80000E+00 .31999E+00	.75484E+00 .80000E+00 .25991E+00	.71327E+00 .74982E+00 .29316E+00	.51490E+00 .13551E+00 .84648E+00	.11795E-01 .81051E-01 .29565E-02	-.99330E-01 -.79953E+00 .22449E-02
5 8 93	.68286E+00 .60000E+00 .33305E+00	.59660E+00 .60000E+00 .37242E+00	.56526E+00 .70000E+00 .36571E+00	.67056E+00 .70000E+00 .32705E+00	.63369E+00 .64985E+00 .34957E+00	.41053E+00 .10519E+00 .90576E+00	.95033E-02 .71750E-01 .12293E-02	-.91464E-01 -.44965E+00 .20087E-01
5 9 94	.67056E+00 .70000E+00 .32705E+00	.56526E+00 .70000E+00 .36571E+00	.57202E+00 .80000E+00 .35761E+00	.65607E+00 .80000E+00 .31999E+00	.62115E+00 .74982E+00 .34265E+00	.40963E+00 .12357E+00 .90384E+00	.93347E-02 .71656E-01 .12089E-02	-.45461E+00 -.95719E-01 -.83469E-01
6 8 95	.59660E+00 .60000E+00 .37242E+00	.50117E+00 .60000E+00 .40574E+00	.49214E+00 .70000E+00 .39853E+00	.56526E+00 .70000E+00 .36571E+00	.54366E+00 .64985E+00 .38564E+00	.33077E+00 .96863E-01 .93852E+00	.10013E-01 .73261E-01 .13252E-02	-.44590E+00 -.88744E-01 -.62307E-01

N P	X1 Y1 Z1	Y2 Z2	Y3 Z3	Y4 Z4	YP ZP	YN ZN	FL C21	C25 C26
6	.56526E+00	.49214E+00	.40151E+00	.57202E+00	.53290E+00	.33015E+00	.98329E-02	-.85893E-01
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.11618E+00	.73059E-01	-.45744E+00
96	.36571E+00	.39853E+00	.36992E+00	.35761E+00	.37801E+00	.93675E+00	.13015E-02	.61012E-02
7	.50117E+00	.42662E+00	.41893E+00	.49214E+00	.45973E+00	.26721E+00	.77037E-02	-.82755E-01
8	.60000E+00	.60000E+00	.70000E+00	.70000E+00	.64985E+00	.94371E-01	.65067E-01	-.33948E+00
97	.40584E+00	.42661E+00	.41893E+00	.39853E+00	.41249E+00	.95901E+00	.70667E-03	.13906E-01
7	.49214E+00	.41893E+00	.40968E+00	.48151E+00	.45063E+00	.26677E+00	.75645E-02	-.34497E+00
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.11097E+00	.64991E-01	-.84695E-01
98	.39853E+00	.41893E+00	.40968E+00	.36972E+00	.40433E+00	.95735E+00	.69751E-03	-.40778E-01
8	.42662E+00	.35801E+00	.35156E+00	.41893E+00	.38879E+00	.21937E+00	.69996E-02	-.33787E+00
8	.60000E+00	.60000E+00	.70000E+00	.70000E+00	.64985E+00	.91641E-01	.62631E-01	-.81273E-01
99	.42661E+00	.44211E+00	.43414E+00	.41893E+00	.43046E+00	.97133E+00	.61405E-03	-.33427E-01
8	.41893E+00	.35156E+00	.34397E+00	.40968E+00	.38110E+00	.21894E+00	.68716E-02	-.80106E-01
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.10773E+00	.62556E-01	-.34635E+00
100	.41893E+00	.43414E+00	.42476E+00	.40968E+00	.42194E+00	.96977E+00	.60579E-03	.57024E-02
9	.35801E+00	.28448E+00	.27936E+00	.35156E+00	.31836E+00	.17545E+00	.74321E-02	-.78097E-01
8	.60000E+00	.60000E+00	.70000E+00	.70000E+00	.64985E+00	.89588E-01	.63660E-01	-.29434E+00
101	.44211E+00	.45527E+00	.44706E+00	.43414E+00	.44466E+00	.98040E+00	.59929E-03	.92829E-02
9	.35156E+00	.27936E+00	.27332E+00	.34397E+00	.31206E+00	.17522E+00	.72964E-02	-.29961E+00
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.10523E+00	.63506E-01	-.78985E-01
102	.43414E+00	.44706E+00	.43741E+00	.42476E+00	.43586E+00	.97889E+00	.59147E-03	-.30987E-01
10	.28448E+00	.22601E+00	.22194E+00	.27936E+00	.25295E+00	.13707E+00	.58729E-02	-.29368E+00
8	.60000E+00	.60000E+00	.70000E+00	.70000E+00	.64985E+00	.88060E-01	.58973E-01	-.77363E-01
103	.45527E+00	.46339E+00	.45504E+00	.44706E+00	.45520E+00	.98664E+00	.44480E-03	-.20947E-01
10	.27936E+00	.22194E+00	.21714E+00	.27332E+00	.24795E+00	.13665E+00	.57654E-02	-.76848E-01
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.10345E+00	.56896E-01	-.30010E+00
104	.44706E+00	.45504E+00	.44521E+00	.43741E+00	.44620E+00	.98518E+00	.44022E-03	.20579E-02
11	.22601E+00	.16165E+00	.15894E+00	.22194E+00	.19219E+00	.10286E+00	.64165E-02	-.76376E-01
8	.60000E+00	.60000E+00	.70000E+00	.70000E+00	.64985E+00	.87001E-01	.60211E-01	-.27183E+00
105	.46339E+00	.47005E+00	.46158E+00	.45504E+00	.46253E+00	.99088E+00	.46998E-03	.62936E-02
11	.22194E+00	.15894E+00	.15530E+00	.21714E+00	.18839E+00	.10272E+00	.62985E-02	-.27698E+00
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.10228E+00	.60054E-01	-.76663E-01
106	.45504E+00	.46158E+00	.45161E+00	.44521E+00	.45338E+00	.98944E+00	.46479E-03	-.17137E-01
12	.16165E+00	.10939E+00	.10742E+00	.15894E+00	.13440E+00	.71485E-01	.52319E-02	-.27160E+00
8	.60000E+00	.60000E+00	.70000E+00	.70000E+00	.64985E+00	.86253E-01	.56976E-01	-.76297E-01
107	.47005E+00	.47382E+00	.46524E+00	.46158E+00	.46770E+00	.99371E+00	.37576E-03	-.11315E-01
12	.15894E+00	.10742E+00	.10519E+00	.15530E+00	.13175E+00	.71363E-01	.51356E-02	-.76146E-01
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.10148E+00	.56875E-01	-.27707E+00
108	.46158E+00	.46524E+00	.45523E+00	.45161E+00	.45845E+00	.99227E+00	.37242E-03	-.80705E-03

M / N / P	X1 / Y1 / Z1	Y2 / Z2	Y3 / Z3	Z4	ZP	ZN	FL / C21	C25 / C26
13	.10939E+00	.50060E-01	.49160E-01	.10742E+00	.79010E-01	.41734E-01	.59064E-02	-.75765E-01
8	.60000E+00	.60000E+00	.70000E+00	.70000E+00	.64985E+00	.85819E-01	.56448E-01	-.26468E+00
109	.47382E+00	.47631E+00	.46773E+00	.46529E+00	.47080E+00	.99544E+00	.41959E-03	.27733E-02
13	.10742E+00	.49160E-01	.48100E-01	.10510E+00	.77448E-01	.41741E-01	.57977E-02	-.27066E+00
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.10097E+00	.56261E-01	-.75856E-01
110	.46529E+00	.46773E+00	.45763E+00	.45523E+00	.46149E+00	.99401E+00	.41551E-03	-.90339E-02
14	.50060E-01	.00000E+00	.00000E+00	.49160E-01	.24806E-01	.13052E-01	.49797E-02	-.26466E+00
8	.60000E+00	.60000E+00	.70000E+00	.70000E+00	.64985E+00	.85672E-01	.56056E-01	-.74860E-01
111	.47631E+00	.47697E+00	.46837E+00	.46773E+00	.47236E+00	.99624E+00	.35211E-03	-.14001E-03
14	.49160E-01	.00000E+00	.00000E+00	.48100E-01	.24316E-01	.12991E-01	.48882E-02	-.74861E-01
9	.70000E+00	.70000E+00	.80000E+00	.80000E+00	.74982E+00	.10064E+00	.55916E-01	-.27066E+00
112	.46773E+00	.46837E+00	.45826E+00	.45763E+00	.46302E+00	.99484E+00	.34946E-03	-.69016E-03

T10 3

M N P	X1 Y1 Z1	X2 Y2 Z2	X3 Y3 Z3	X4 Y4 Z4	XP YP ZP	XN YN ZN	A FL C21	C24 C25 C26
1	.91652E+00	.89691E+00	.87393E+00	.89303E+00	.89515E+00	.95368E+00	.97532E-02	-.15883E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.22618E+00	.71152E-01	-.19307E+01
113	.00000E+00	.94270E-01	.91850E-01	.00000E+00	.40532E-01	.19835E+00	.47754E-02	.54269E-01
1	.89303E+00	.87393E+00	.84750E+00	.86603E+00	.87019E+00	.94593E+00	.95575E-02	-.19703E+01
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.25792E+00	.70725E-01	-.16172E+00
114	.00000E+00	.91850E-01	.89080E-01	.00000E+00	.45236E-01	.19674E+00	.46322E-02	-.15495E+00
2	.89691E+00	.83210E+00	.81077E+00	.87393E+00	.85347E+00	.81614E+00	.11826E-01	-.18954E+01
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.20368E+00	.80704E-01	-.15974E+00
115	.94270E-01	.19210E+00	.18718E+00	.91850E-01	.14136E+00	.54070E+00	.67383E-02	-.34037E+00
2	.87393E+00	.81077E+00	.78626E+00	.84750E+00	.82968E+00	.81074E+00	.11570E-01	-.14302E+00
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.23283E+00	.80198E-01	-.19524E+01
116	.91850E-01	.18718E+00	.18152E+00	.89080E-01	.13742E+00	.53712E+00	.65053E-02	-.30608E-01
3	.83210E+00	.75484E+00	.73550E+00	.81077E+00	.78335E+00	.64938E+00	.10306E-01	-.12539E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.17592E+00	.75945E-01	-.82417E+00
117	.19210E+00	.25991E+00	.25325E+00	.18718E+00	.22312E+00	.73984E+00	.24193E-02	.46672E-01
3	.81077E+00	.73550E+00	.71326E+00	.78626E+00	.76151E+00	.64617E+00	.10068E-01	-.83314E+00
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.20125E+00	.75697E-01	-.14033E+00
118	.18718E+00	.25325E+00	.24559E+00	.18152E+00	.21690E+00	.73619E+00	.23574E-02	-.21452E+00
4	.75484E+00	.65607E+00	.63926E+00	.73550E+00	.69646E+00	.51326E+00	.11553E-[illegible]	-.80654E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.15678E+00	.80700E-01	-.12436E+00
119	.25991E+00	.31999E+00	.31179E+00	.25325E+00	.28625E+00	.84379E+00	.29167E-02	-.18447E+00
4	.73550E+00	.63926E+00	.61993E+00	.71326E+00	.67704E+00	.51123E+00	.11275E-01	-.11163E+00
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.17958E+00	.80262E-01	-.84157E+00
120	.25325E+00	.31179E+00	.30236E+00	.24559E+00	.27827E+00	.84047E+00	.28341E-02	.53465E-02
5	.65607E+00	.57262E+00	.55794E+00	.63926E+00	.60651E+00	.40852E+00	.91364E-02	-.10341E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.14306E+00	.71502E-01	-.47041E+00
121	.31999E+00	.35761E+00	.34864E+00	.31179E+00	.33458E+00	.90147E+00	.12157E-02	.29912E-01
5	.63926E+00	.55794E+00	.54107E+00	.61993E+00	.58960E+00	.40719E+00	.89129E-02	-.47637E+00
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.16393E+00	.71298E-01	-.11144E+00
122	.31179E+00	.34864E+00	.33810E+00	.30236E+00	.32525E+00	.89851E+00	.11867E-02	-.11671E+00
6	.57262E+00	.48151E+00	.46917E+00	.55794E+00	.52034E+00	.32939E+00	.96231E-02	-.46315E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.13454E+00	.72786E-01	-.10259E+00
123	.35781E+00	.38992E+00	.37993E+00	.34864E+00	.36910E+00	.93456E+00	.13034E-02	-.88188E-01
6	.55794E+00	.46917E+00	.45498E+00	.54107E+00	.50563E+00	.32843E+00	.93816E-02	-.97042E-01
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.15422E+00	.72444E-01	-.48170E+00
124	.34864E+00	.37993E+00	.36844E+00	.33810E+00	.35861E+00	.93165E+00	.12720E-02	.99147E-02
7	.48151E+00	.40968E+00	.37937E+00	.46917E+00	.44001E+00	.26614E+00	.74020E-02	-.93465E-01
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.12653E+00	.64877E-01	-.35428E+00
125	.38992E+00	.40966E+00	.39937E+00	.37993E+00	.39480E+00	.95533E+00	.71175E-03	.18861E-01

N	Y1	Y2	Y3	Y4	YP	YN	FL	C25
P	Z1	Z2	Z3	Z4	ZP	ZN	C21	C26
7	.46917E+00	.39937E+00	.36730E+00	.45458E+00	.42774E+00	.26544E+00	.72142E-02	-.36060E+00
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.14733E+00	.64724E-01	-.97270E-01
126	.37993E+00	.39937E+00	.36730E+00	.36344E+00	.38379E+00	.95280E+00	.64872E-03	-.69119E-01
8	.40988E+00	.34397E+00	.33515E+00	.39937E+00	.37211E+00	.21858E+00	.67228E-02	-.35124E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.12460E+00	.62451E-01	-.93302E-01
127	.40988E+00	.42476E+00	.41388E+00	.39937E+00	.41200E+00	.96781E+00	.62211E-03	-.50965E-01
8	.39937E+00	.33515E+00	.32502E+00	.36730E+00	.30174E+00	.21803E+00	.65515E-02	-.90772E-01
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.14308E+00	.62313E-01	-.36324E+00
128	.39937E+00	.41388E+00	.40136E+00	.36730E+00	.40051E+00	.96540E+00	.61141E-03	.75268E-02
9	.34397E+00	.27332E+00	.26632E+00	.33515E+00	.30471E+00	.17491E+00	.71380E-02	-.89694E-01
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.12191E+00	.63308E-01	-.30818E+00
129	.42476E+00	.43741E+00	.42620E+00	.41388E+00	.42559E+00	.97701E+00	.61310E-03	.13815E-01
9	.33515E+00	.26632E+00	.25826E+00	.32502E+00	.29621E+00	.17446E+00	.69555E-02	-.31483E+00
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94975E+00	.13988E+00	.63072E-01	-.91289E-01
130	.41388E+00	.42620E+00	.41331E+00	.40136E+00	.41372E+00	.97468E+00	.60265E-03	-.41935E-01
10	.27332E+00	.21714E+00	.21158E+00	.26632E+00	.24210E+00	.13653E+00	.56398E-02	-.30687E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.11988E+00	.58790E-01	-.88974E-01
131	.43741E+00	.44521E+00	.43380E+00	.42620E+00	.43568E+00	.98336E+00	.46459E-03	-.28412E-01
10	.26632E+00	.21158E+00	.20518E+00	.25826E+00	.23535E+00	.13622E+00	.54949E-02	-.88006E-01
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.13754E+00	.58670E-01	-.31587E+00
132	.42620E+00	.43380E+00	.42066E+00	.41331E+00	.42353E+00	.96109E+00	.45820E-03	.56902E-02
11	.21714E+00	.15550E+00	.15152E+00	.21158E+00	.18395E+00	.10258E+00	.61611E-02	-.87392E-01
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.11847E+00	.59860E-01	-.28457E+00
133	.44521E+00	.45161E+00	.44004E+00	.43380E+00	.44269E+00	.98764E+00	.48797E-03	.99345E-02
11	.21158E+00	.15152E+00	.14694E+00	.20518E+00	.17882E+00	.10237E+00	.60025E-02	-.29102E+00
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.13596E+00	.59641E-01	-.87909E-01
134	.43380E+00	.44004E+00	.42673E+00	.42068E+00	.43035E+00	.98541E+00	.46017E-03	-.23462E-01
12	.15550E+00	.10510E+00	.10241E+00	.15152E+00	.12864E+00	.71171E-01	.50231E-02	-.28409E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.11748E+00	.56752E-01	-.86972E-01
135	.45161E+00	.45523E+00	.44357E+00	.44004E+00	.44764E+00	.99052E+00	.39655E-03	-.14602E-01
12	.15152E+00	.10241E+00	.99310E-01	.14694E+00	.12505E+00	.71105E-01	.46942E-02	-.86678E-01
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94975E+00	.13463E+00	.56620E-01	-.29133E+00
136	.44004E+00	.44357E+00	.43016E+00	.42673E+00	.43516E+00	.98831E+00	.39263E-03	.32386E-02
13	.10510E+00	.48100E-01	.46870E-01	.10241E+00	.75624E-01	.41704E-01	.56708E-02	-.86052E-01
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.11694E+00	.56047E-01	-.27709E+00
137	.45523E+00	.45763E+00	.44590E+00	.44357E+00	.45061E+00	.99226E+00	.43715E-03	.37690E-02
13	.10241E+00	.46870E-01	.45450E-01	.99310E-01	.73516E-01	.41540E-01	.55247E-02	-.28423E+00
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.13414E+00	.57812E-01	-.86138E-01
138	.44357E+00	[illegible]	.43242E+00	.43016E+00	.43605E+00	.99009E+00	.43210E-03	-.96325E-02

M N P	X1 Y1 Z1	X2 Y2 Z2	X3 Y3 Z3	X4 Y4 Z4	XP YP ZP	XN YN ZN	A FL C21	C24 C25 C26
14	.48100E-01	.00000E+00	.00000E+00	.46870E-01	.23744E-01	.12966E-01	.47816E-02	-.27705E+00
11	.80000E+00	.80000E+00	.90000E+00	.90000E+00	.84978E+00	.11671E+00	.55761E-01	-.85562E-01
139	.45763E+00	.45926E+00	.44651E+00	.44590E+00	.45210E+00	.99308E+00	.37342E-03	-.17241E-02
14	.46870E-01	.00000E+00	.00000E+00	.45450E-01	.23082E-01	.12860E-01	.46583E-02	-.85565E-01
12	.90000E+00	.90000E+00	.10000E+01	.10000E+01	.94974E+00	.13382E+00	.55594E-01	-.28422E+00
140	.44590E+00	.44651E+00	.43301E+00	.43242E+00	.43949E+00	.99092E+00	.36915E-03	-.22173E-02
1	.86603E+00	.84750E+00	.81730E+00	.83516E+00	.84159E+00	.93643E+00	.93353E-02	-.18265E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.29165E+00	.70273E-01	-.20237E+01
141	.00000E+00	.89060E-01	.85900E-01	.00000E+00	.43750E-01	.19474E+00	.45329E-02	.74322E-01
1	.83516E+00	.81730E+00	.78289E+00	.80000E+00	.80896E+00	.92479E+00	.90835E-02	-.20795E+01
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.32832E+00	.69825E-01	-.18759E+00
142	.00000E+00	.85900E-01	.82280E-01	.00000E+00	.42052E-01	.19229E+00	.43481E-02	-.20849E+00
2	.84750E+00	.78626E+00	.75824E+00	.81730E+00	.80241E+00	.80410E+00	.11279E-01	-.19718E+01
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.26391E+00	.79621E-01	-.19478E+00
143	.89060E-01	.18152E+00	.17505E+00	.85900E-01	.13290E+00	.53270E+00	.63010E-02	-.45905E+00
2	.81730E+00	.75824E+00	.72631E+00	.78289E+00	.77130E+00	.79588E+00	.10951E-01	-.16524E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.29759E+00	.79005E-01	-.20565E+01
144	.85900E-01	.17505E+00	.16768E+00	.82280E-01	.12775E+00	.52727E+00	.60008E-02	-.36669E-01
3	.78626E+00	.71326E+00	.68784E+00	.75824E+00	.73648E+00	.64218E+00	.97965E-02	-.14684E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.22859E+00	.75410E-01	-.87831E+00
145	.18152E+00	.24559E+00	.23684E+00	.17505E+00	.20977E+00	.73168E+00	.23454E-02	.67158E-01
3	.75824E+00	.68784E+00	.65888E+00	.72631E+00	.70793E+00	.63726E+00	.94885E-02	-.88764E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.25845E+00	.75096E-01	-.17359E+00
146	.17505E+00	.23684E+00	.22687E+00	.16768E+00	.20164E+00	.72602E+00	.22660E-02	-.29497E+00
4	.71326E+00	.61993E+00	.59784E+00	.68784E+00	.65479E+00	.50875E+00	.10956E-01	-.84725E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.20417E+00	.79746E-01	-.15385E+00
147	.24559E+00	.30236E+00	.29159E+00	.23684E+00	.26912E+00	.83635E+00	.27911E-02	-.25303E+00
4	.68784E+00	.59784E+00	.57267E+00	.65888E+00	.62940E+00	.50562E+00	.10595E-01	-.13067E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.23122E+00	.79164E-01	-.90333E+00
148	.23684E+00	.29159E+00	.27931E+00	.22687E+00	.25669E+00	.83120E+00	.26819E-02	.11636E-01
5	.61993E+00	.54107E+00	.52179E+00	.59784E+00	.57022E+00	.40552E+00	.86547E-02	-.12288E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.18655E+00	.71050E-01	-.50209E+00
149	.30236E+00	.33810E+00	.32605E+00	.29159E+00	.31456E+00	.89465E+00	.12103E-02	.44606E-01
5	.59784E+00	.52179E+00	.49982E+00	.57267E+00	.54611E+00	.40339E+00	.83617E-02	-.50818E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.21149E+00	.70777E-01	-.13726E+00
150	.29159E+00	.32605E+00	.31232E+00	.27931E+00	.30236E+00	.89025E+00	.11756E-02	-.15997E+00
6	.54107E+00	.45498E+00	.43877E+00	.52179E+00	.48921E+00	.32723E+00	.91057E-02	-.48886E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.17566E+00	.72044E-01	-.12523E+00
151	.33810E+00	.35544E+00	.33531E+00	.32605E+00	.34701E+00	.92849E+00	.12863E-02	-.12102E+00

N	Y1	Y2	Y3	Y4	YP	YN	FL	C25
P	Z1	Z2	Z3	Z4	ZP	ZN	C21	C26
6	.52179E+00	.43577E+00	.42030E+00	.44962E+00	.47024E+00	.32576E+00	.87920E-02	-.11502E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.19917E+00	.71597E-01	-.51813E+00
152	.32605E+00	.35531E+00	.34035E+00	.31232E+00	.33356E+00	.92423E+00	.12457E-02	.18433E-01
7	.45498E+00	.38730E+00	.37350E+00	.43877E+00	.41368E+00	.26464E+00	.69998E-02	-.11220E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.16783E+00	.64546E-01	-.37851E+00
153	.36844E+00	.38730E+00	.37350E+00	.35531E+00	.37116E+00	.94963E+00	.73579E-03	.30637E-01
7	.43877E+00	.37350E+00	.35777E+00	.42030E+00	.39765E+00	.26350E+00	.67567E-02	-.38639E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.19045E+00	.64357E-01	-.11872E+00
154	.35531E+00	.37350E+00	.35777E+00	.34035E+00	.35679E+00	.94567E+00	.71938E-03	-.92806E-01
8	.36730E+00	.32502E+00	.31343E+00	.37350E+00	.34985E+00	.21726E+00	.63562E-02	-.37270E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.16300E+00	.62163E-01	-.11332E+00
155	.38730E+00	.40136E+00	.38706E+00	.37350E+00	.38735E+00	.96241E+00	.64975E-03	-.68153E-01
8	.37350E+00	.31343E+00	.30024E+00	.35777E+00	.33629E+00	.21642E+00	.61337E-02	-.10878E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.18504E+00	.61997E-01	-.39126E+00
156	.37350E+00	.38706E+00	.37076E+00	.35777E+00	.37233E+00	.95861E+00	.63609E-03	.16074E-01
9	.32502E+00	.25826E+00	.24906E+00	.31343E+00	.28647E+00	.17393E+00	.67467E-02	-.10727E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.15933E+00	.62805E-01	-.32650E+00
157	.40136E+00	.41331E+00	.39858E+00	.38706E+00	.40012E+00	.97178E+00	.63582E-03	.21138E-01
9	.31343E+00	.24906E+00	.23857E+00	.30024E+00	.27537E+00	.17329E+00	.65093E-02	-.33599E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.18086E+00	.62513E-01	-.11019E+00
158	.38706E+00	.39858E+00	.38180E+00	.37076E+00	.38461E+00	.96812E+00	.62252E-03	-.58258E-01
10	.25826E+00	.20518E+00	.19787E+00	.24906E+00	.22762E+00	.13585E+00	.53293E-02	-.32403E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.15668E+00	.58534E-01	-.10716E+00
159	.41331E+00	.42068E+00	.40569E+00	.39858E+00	.40961E+00	.97826E+00	.49586E-03	-.39703E-01
10	.24906E+00	.19787E+00	.18954E+00	.23857E+00	.21879E+00	.13538E+00	.51410E-02	-.10532E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.17786E+00	.58400E-01	-.33787E+00
160	.39858E+00	.40569E+00	.38861E+00	.38180E+00	.39373E+00	.97470E+00	.46844E-03	.95512E-02
11	.20518E+00	.14694E+00	.14170E+00	.19787E+00	.17294E+00	.10212E+00	.58214E-02	-.10501E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.15485E+00	.59400E-01	-.30131E+00
161	.42068E+00	.42673E+00	.41153E+00	.40569E+00	.41620E+00	.98265E+00	.51826E-03	.14596E-01
11	.19787E+00	.14170E+00	.13573E+00	.18954E+00	.16624E+00	.10176E+00	.56160E-02	-.31245E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.17586E+00	.59147E-01	-.10592E+00
162	.40569E+00	.41153E+00	.39420E+00	.38861E+00	.40007E+00	.97914E+00	.51045E-03	-.31981E-01
12	.14694E+00	.99310E-01	.95770E-01	.14170E+00	.12094E+00	.70895E-01	.47464E-02	-.30043E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.15362E+00	.56480E-01	-.10464E+00
163	.42673E+00	.43016E+00	.41483E+00	.41153E+00	.42086E+00	.98558E+00	.43316E-03	-.17898E-01
12	.14170E+00	.95770E-01	.91740E-01	.13573E+00	.11625E+00	.70558E-01	.45778E-02	-.10418E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.17448E+00	.56340E-01	-.31293E+00
164	.41153E+00	.41483E+00	.39735E+00	.39420E+00	.40454E+00	.98213E+00	.42784E-03	.35531E-02

N P	Y1 Z1	Y2 Z2	Y3 Z3	Y4 Z4	YP ZP	YN ZN	FL C21	C25 C26
13	.99310E-01	.45450E-01	.43530E-01	.95770E-01	.71098E-01	.41436E-01	.53576E-02	-.10373E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.15291E+00	.57556E-01	-.29333E+00
165	.43016E+00	.43242E+00	.41701E+00	.41483E+00	.42365E+00	.98737E+00	.47113E-03	.76684E-02
13	.95770E-01	.43830E-01	.41960E-01	.91740E-01	.68341E-01	.41312E-01	.51679E-02	-.30358E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.17364E+00	.57293E-01	-.10386E+00
166	.41483E+00	.41701E+00	.39945E+00	.39736E+00	.40723E+00	.98394E+00	.46392E-03	-.13463E-01
14	.45450E-01	.00000E+00	.00000E+00	.43830E-01	.22322E-01	.12840E-01	.45172E-02	-.29321E+00
13	.10000E+01	.10000E+01	.11000E+01	.11000E+01	.10497E+01	.15253E+00	.55421E-01	-.10339E+00
167	.43242E+00	.43301E+00	.41758E+00	.41701E+00	.42505E+00	.98822E+00	.41069E-03	-.37618E-02
14	.43830E-01	.00000E+00	.00000E+00	.41960E-01	.21456E-01	.12854E-01	.43567E-02	-.10337E+00
14	.11000E+01	.11000E+01	.12000E+01	.12000E+01	.11496E+01	.17319E+00	.55250E-01	-.30357E+00
168	.41701E+00	.41758E+00	.40000E+00	.39945E+00	.40857E+00	.98480E+00	.40660E-03	-.12933E-02

M N P	X1 Y1 Z1	X2 Y2 Z2	X3 Y3 Z3	X4 Y4 Z4	X5 Y5 Z5	X6 Y6 Z6	A FL C21	C24 C25 C26
1	.80000E+00	.75289E+00	.74368E+00	.75993E+00	.77179E+00	.91027E+00	.88015E-02	-.22103E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.38822E+00	.69428E-01	-.21565E+01
169	.00000E+00	.82280E-01	.78160E-01	.00000E+00	.40119E-01	.18927E+00	.42490E-02	.10084E+00
1	.75993E+00	.74368E+00	.69857E+00	.71414E+00	.72939E+00	.89197E+00	.84851E-02	-.22359E+01
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.41232E+00	.69143E-01	-.22951E+00
170	.00000E+00	.78160E-01	.73450E-01	.00000E+00	.37915E-01	.18544E+00	.40165E-02	-.28226E+00
2	.78289E+00	.72631E+00	.66994E+00	.74368E+00	.73587E+00	.76560E+00	.10580E-01	-.20778E+01
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.33459E+00	.78372E-01	-.25177E+00
171	.82280E-01	.16768E+	.15928E+00	.78160E-01	.12108E+00	.52046E+00	.57658E-02	-.61434E+00
2	.74368E+00	.68994E+00	.64836E+00	.69867E+00	.69544E+00	.77249E+00	.10164E-01	-.20059E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.37595E+00	.77785E-01	-.22108E+01
172	.78160E-01	.15928E+00	.14969E+00	.73450E-01	.11518E+00	.51177E+00	.53842E-02	-.39262E-01
3	.72631E+00	.65888E+00	.62568E+00	.68994E+00	.67540E+00	.63103E+00	.91410E-02	-.18219E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.29154E+00	.74789E-01	-.96117E+00
173	.16768E+00	.22687E+00	.21551E+00	.15928E+00	.19236E+00	.71869E+00	.22799E-02	.99881E-01
3	.68994E+00	.62568E+00	.58817E+00	.64836E+00	.63829E+00	.62296E+00	.87481E-02	-.96919E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.32895E+00	.74543E-01	-.22998E+00
174	.15928E+00	.21551E+00	.20252E+00	.14969E+00	.18181E+00	.70973E+00	.21815E-02	-.40906E+00
4	.65888E+00	.57267E+00	.54399E+00	.62568E+00	.60049E+00	.50162E+00	.10186E-01	-.90666E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.26133E+00	.78546E-01	-.20387E+00
175	.22687E+00	.27931E+00	.26532E+00	.21551E+00	.24661E+00	.82467E+00	.26543E-02	-.34590E+00
4	.62568E+00	.54399E+00	.51121E+00	.58817E+00	.56749E+00	.49645E+00	.97244E-02	-.16206E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.29558E+00	.77931E-01	-.99884E+00
176	.21551E+00	.26532E+00	.24933E+00	.20252E+00	.23325E+00	.81619E+00	.25144E-02	.26612E-01
5	.57267E+00	.49982E+00	.47479E+00	.54399E+00	.52293E+00	.40076E+00	.80298E-02	-.15546E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.23933E+00	.70502E-01	-.55061E+00
177	.27931E+00	.31232E+00	.29668E+00	.26532E+00	.26847E+00	.88437E+00	.12288E-02	.70403E-01
5	.54399E+00	.47479E+00	.44618E+00	.51121E+00	.49420E+00	.39730E+00	.76538E-02	-.55702E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.27118E+00	.70265E-01	-.18187E+00
178	.26532E+00	.29668E+00	.27880E+00	.24933E+00	.27262E+00	.87670E+00	.11866E-02	-.22485E+00
6	.49982E+00	.42030E+00	.39925E+00	.47479E+00	.44864E+00	.32384E+00	.84364E-02	-.52634E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.22557E+00	.71125E-01	-.16421E+00
179	.31232E+00	.34035E+00	.32330E+00	.29668E+00	.31823E+00	.91883E+00	.12865E-02	-.16638E+00
6	.47479E+00	.39925E+00	.37519E+00	.44618E+00	.42399E+00	.32132E+00	.80337E-02	-.14536E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.25581E+00	.70660E-01	-.57560E+00
180	.29668E+00	.32330E+00	.30362E+00	.27880E+00	.30075E+00	.91176E+00	.12384E-02	.33798E-01
7	.42030E+00	.35777E+00	.33985E+00	.37925E+00	.37930E+00	.26206E+00	.64810E-02	-.14331E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.21561E+00	.64173E-01	-.41212E+00
181	.34035E+00	.35777E+00	.33985E+00	.32330E+00	.34039E+00	.94061E+00	.76457E-03	.47916E-01

N P	Y1 Z1	Y2 Z2	Y3 Z3	Y4 Z4	YP ZP	Y6 Z6	A FL C21	C25 C26
7	.39925E+00	.33965E+00	.31737E+00	.37514E+00	.35033E+00	.26021E+00	.61677E-02	-.42259E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13475E+01	.24467E+00	.64024E-01	-.15556E+00
182	.32330E+00	.33965E+00	.31737E+00	.30502E+00	.32187E+00	.93379E+00	.76507E-03	-.13147E+00
8	.35777E+00	.30024E+00	.26526E+00	.33965E+00	.32084E+00	.21535E+00	.56807E-02	-.40140E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.20972E+00	.61542E-01	-.14729E+00
183	.35777E+00	.37076E+00	.35224E+00	.33965E+00	.35522E+00	.95375E+00	.70266E-03	-.94692E-01
8	.33965E+00	.26526E+00	.26862E+00	.31937E+00	.30321E+00	.21397E+00	.55940E-02	-.13868E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.23805E+00	.61722E-01	-.43184E+00
184	.33965E+00	.35219E+00	.33097E+00	.31937E+00	.33570E+00	.94739E+00	.66723E-03	.28727E-01
9	.30024E+00	.23857E+00	.22663E+00	.26520E+00	.26272E+00	.17251E+00	.62399E-02	-.13832E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.20504E+00	.62217E-01	-.35532E+00
185	.37076E+00	.38180E+00	.36268E+00	.35219E+00	.35694E+00	.96343E+00	.69128E-03	.34304E-01
9	.28520E+00	.22663E+00	.21297E+00	.26862E+00	.24828E+00	.17137E+00	.59341E-02	-.36873E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.23266E+00	.61940E-01	-.14351E+00
186	.35219E+00	.36268E+00	.34062E+00	.33097E+00	.34675E+00	.95729E+00	.67611E-03	-.80040E-01
10	.23857E+00	.18954E+00	.18005E+00	.22663E+00	.20874E+00	.13475E+00	.49275E-02	-.35062E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.20167E+00	.56277E-01	-.13962E+00
187	.38180E+00	.38861E+00	.36915E+00	.36268E+00	.37564E+00	.97014E+00	.56262E-03	-.54726E-01
10	.22663E+00	.18005E+00	.16920E+00	.21297E+00	.19726E+00	.13392E+00	.46854E-02	-.13613E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.22914E+00	.58196E-01	-.37236E+00
188	.36268E+00	.36915E+00	.34690E+00	.34062E+00	.35500E+00	.96414E+00	.55447E-03	.17787E-01
11	.18954E+00	.13573E+00	.12894E+00	.18005E+00	.15860E+00	.10126E+00	.53822E-02	-.13587E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.19939E+00	.56891E-01	-.32739E+00
189	.38861E+00	.39420E+00	.37446E+00	.36915E+00	.38169E+00	.97467E+00	.58130E-03	.21314E-01
11	.18005E+00	.12894E+00	.12127E+00	.16920E+00	.14989E+00	.10065E+00	.51166E-02	-.34181E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.22659E+00	.58662E-01	-.13767E+00
190	.36915E+00	.37446E+00	.35169E+00	.34690E+00	.36072E+00	.96878E+00	.57120E-03	-.46236E-01
12	.13573E+00	.91740E-01	.87140E-01	.12894E+00	.11091E+00	.70203E-01	.43872E-02	-.32581E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.19762E+00	.56217E-01	-.13538E+00
191	.39420E+00	.39736E+00	.37746E+00	.37446E+00	.38595E+00	.97772E+00	.50182E-03	-.26605E-01
12	.12894E+00	.87140E-01	.81890E-01	.12117E+00	.10482E+00	.69886E-01	.41712E-02	-.13437E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.22476E+00	.56132E-01	-.34289E+00
192	.37446E+00	.37746E+00	.35472E+00	.35169E+00	.36475E+00	.97190E+00	.49717E-03	.10263E-01
13	.91740E-01	.41980E-01	.39860E-01	.87140E-01	.65199E-01	.41092E-01	.49522E-02	-.13365E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.19692E+00	.57032E-01	-.31497E+00
193	.39736E+00	.39945E+00	.37944E+00	.37746E+00	.38851E+00	.97956E+00	.53337E-03	.10015E-01
13	.87140E-01	.39860E-01	.37490E-01	.81890E-01	.61617E-01	.40792E-01	.47067E-02	-.33052E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13495E+01	.22366E+00	.56794E-01	-.13409E+00
194	.37746E+00	.37944E+00	.35656E+00	.35472E+00	.36717E+00	.97361E+00	.52639E-03	-.16347E-01

M N P	X1 Y1 Z1	Y2 Z2	Y3 Z3	Y4 Z4	YP ZP	YN ZN	FL CZ1	C25 CZ6
14	.41960E-01	.00000E+00	.00000E+00	.39800E-01	.20470E-01	.12936E-01	.41747E-02	-.31477E+00
16	.12000E+01	.12000E+01	.13000E+01	.13000E+01	.12496E+01	.19543E+00	.55095E-01	-.13386E+00
195	.39945E+00	.40000E+00	.37997E+00	.37994E+00	.38980E+00	.96043E+00	.47934E-03	-.66545E-02
14	.39880E-01	.00000E+00	.00000E+00	.37420E-01	.19346E-01	.12850E-01	.39684E-02	-.13384E+00
17	.13000E+01	.13000E+01	.14000E+01	.14000E+01	.13475E+01	.22317E+00	.54979E-01	-.33046E+00
196	.37944E+00	.37997E+00	.35707E+00	.35658E+00	.36838E+00	.97469E+00	.47522E-03	-.43108E-02
1	.71414E+00	.69867E+00	.64729E+00	.66144E+00	.66077E+00	.86837E+00	.81305E-02	-.28617E+00
18	.14000E+01	.14000E+01	.15000E+01	.15000E+01	.14494E+01	.46166E+00	.69096E-01	-.23501E+01
197	.00000E+00	.73450E-01	.68030E-01	.00000E+00	.35388E-01	.16057E+00	.39633E-02	.14072E+00
1	.66144E+00	.64729E+00	.58717E+00	.60000E+00	.62447E+00	.83696E+00	.77321E-02	-.24694E+01
19	.15000E+01	.15000E+01	.16000E+01	.16000E+01	.15492E+01	.51885E+00	.69505E-01	-.30123E+00
198	.00000E+00	.68030E-01	.61710E-01	.00000E+00	.32461E-01	.17405E+00	.36924E-02	-.39350E+00
2	.69887E+00	.64836E+00	.60051E+00	.64729E+00	.64908E+00	.75541E+00	.96946E-02	-.22254E+01
18	.14000E+01	.14000E+01	.15000E+01	.15000E+01	.14494E+01	.42296E+00	.77337E-01	-.35177E+00
199	.73450E-01	.14969E+00	.13864E+00	.68030E-01	.10751E+00	.56047E+00	.51558E-02	-.83269E+00
2	.64729E+00	.60051E+00	.54473E+00	.58717E+00	.57540E+00	.73233E+00	.91642E-02	-.26111E+00
19	.15000E+01	.15000E+01	.16000E+01	.16000E+01	.15492E+01	.47777E+00	.77219E-01	-.24388E+01
200	.68030E-01	.13864E+00	.12576E+00	.61710E-01	.98613E-01	.48521E+00	.46834E-02	-.32906E-01
3	.64836E+00	.58817E+00	.54476E+00	.60051E+00	.59574E+00	.61234E+00	.83039E-02	-.24578E+00
18	.14000E+01	.14000E+01	.15000E+01	.15000E+01	.14494E+01	.37202E+00	.74446E-01	-.10949E+01
201	.14969E+00	.20252E+00	.18758E+00	.13864E+00	.16969E+00	.69760E+00	.22719E-02	.16084E+00
3	.60051E+00	.54476E+00	.49416E+00	.54473E+00	.54647E+00	.59769E+00	.78003E-02	-.10990E+01
19	.15000E+01	.15000E+01	.16000E+01	.16000E+01	.15492E+01	.42327E+00	.74671E-01	-.33719E+00
202	.13864E+00	.18758E+00	.17015E+00	.12576E+00	.15566E+00	.66088E+00	.21586E-02	-.59721E+00
4	.58817E+00	.51121E+00	.47348E+00	.54476E+00	.52966E+00	.48955E+00	.92006E-02	-.99472E+00
18	.14000E+01	.14000E+01	.15000E+01	.15000E+01	.14494E+01	.33532E+00	.77396E-01	-.29853E+00
203	.20252E+00	.24933E+00	.23093E+00	.18758E+00	.21770E+00	.60492E+00	.25481E-02	-.48726E+00
4	.54476E+00	.47348E+00	.42950E+00	.49416E+00	.48566E+00	.47998E+00	.86037E-02	-.21846E+00
19	[illegible]000E+01	.15000E+01	.16000E+01	.16000E+01	.15492E+01	.38320E+00	.77079E-01	-.11594E+01
204	.18758E+00	.23093E+00	.20948E+00	.17015E+00	.19969E+00	.78917E+00	.23761E-02	.63041E-01
5	.51121E+00	.44619E+00	.41325E+00	.47348E+00	.46126E+00	.39269E+00	.72267E-02	-.21663E+00
18	.14000E+01	.14000E+01	.15000E+01	.15000E+01	.14494E+01	.30832E+00	.70134E-01	-.63115E+00
205	.24933E+00	.27860E+00	.25823E+00	.23093E+00	.25445E+00	.86645E+00	.13235E-02	.11900E+00
5	.47348E+00	.41325E+00	.37437E+00	.42950E+00	.42311E+00	.36618E+00	.67384E-02	-.63560E+00
19	.15000E+01	.15000E+01	.16000E+01	.16000E+01	.15492E+01	.35342E+00	.70240E-01	-.26950E+00
206	.23093E+00	.25823E+00	.23424E+00	.20948E+00	.23340E+00	.85203E+00	.12781E-02	-.33435E+00
6	.44618E+00	.37519E+00	.34750E+00	.41325E+00	.37572E+00	.31798E+00	.75756E-02	-.58438E+00
18	.14000E+01	.14000E+01	.15000E+01	.15000E+01	.14494E+01	.29120E+00	.70258E-01	-.24056E+00
207	.27880E+00	.30342E+00	.28140E+00	.25823E+00	.26070E+00	.90227E+00	.13596E-02	-.23942E+00

M N P	X1 Y1 Z1	X2 Y2 Z2	X3 Y3 Z3	X4 Y4 Z4	XP YP ZP	XN YN ZN	A FL C21	C24 C25 C26
6 19 208	.41325E+00 .15000E+01 .25823E+00	.34750E+00 .15000E+01 .25140E+00	.31522E+00 .16000E+01 .25520E+00	.37907E+00 .16000E+01 .23424E+00	.30300E+00 .15492E+01 .25749E+00	.31323E+00 .33441E+00 .88865E+00	.70518E-02 .70033E-01 .13021E-02	-.20233E+00 -.67455E+00 .69448E-01
7 18 209	.37519E+00 .14000E+01 .30382E+00	.31937E+00 .14000E+01 .31937E+00	.29500E+00 .15000E+01 .27500E+00	.34750E+00 .15000E+01 .28140E+00	.33403E+00 .14494E+01 .30024E+00	.25768E+00 .27901E+00 .92507E+00	.58111E-02 .63967E-01 .91582E-03	-.20403E+00 -.46721E+00 .82230E-01
7 19 210	.34750E+00 .15000E+01 .28140E+00	.29560E+00 .15000E+01 .29560E+00	.26833E+00 .16000E+01 .26833E+00	.31522E+00 .16000E+01 .25526E+00	.30696E+00 .15492E+01 .27542E+00	.25422E+00 .32076E+00 .91241E+00	.54023E-02 .64107E-01 .89906E-03	-.48379E+00 -.22947E+00 -.19957E+00
8 18 211	.31937E+00 .14000E+01 .31937E+00	.26802E+00 .14000E+01 .33097E+00	.24824E+00 .15000E+01 .30654E+00	.29560E+00 .15000E+01 .29580E+00	.26300E+00 .14494E+01 .31332E+00	.21204E+00 .27143E+00 .93861E+00	.52676E-02 .61693E-01 .83859E-03	-.44625E+00 -.21442E+00 -.13549E+00
8 19 212	.29580E+00 .15000E+01 .29580E+00	.24824E+00 .15000E+01 .30654E+00	.22518E+00 .16000E+01 .27807E+00	.26833E+00 .16000E+01 .26833E+00	.25959E+00 .15492E+01 .26741E+00	.20922E+00 .31220E+00 .92669E+00	.48941E-02 .61850E-01 .82595E-03	-.19676E+00 -.50302E+00 .56076E-01
9 18 213	.26802E+00 .14000E+01 .33097E+00	.21297E+00 .14000E+01 .34082E+00	.19725E+00 .15000E+01 .31567E+00	.24824E+00 .15000E+01 .30654E+00	.23173E+00 .14494E+01 .32366E+00	.16966E+00 .26557E+00 .94901E+00	.55866E-02 .61730E-01 .82520E-03	-.19874E+00 -.40001E+00 .59023E-01
9 19 214	.24824E+00 .15000E+01 .30654E+00	.19725E+00 .15000E+01 .31567E+00	.17693E+00 .16000E+01 .26635E+00	.22518E+00 .16000E+01 .27807E+00	.21257E+00 .15492E+01 .29689E+00	.16760E+00 .30567E+00 .93723E+00	.51874E-02 .61667E-01 .81208E-03	-.42200E+00 -.20970E+00 -.12250E+00
10 18 215	.21297E+00 .14000E+01 .34082E+00	.16920E+00 .14000E+01 .34690E+00	.15671E+00 .15000E+01 .32130E+00	.19725E+00 .15000E+01 .31567E+00	.16412E+00 .14494E+01 .33133E+00	.13279E+00 .26133E+00 .95607E+00	.44092E-02 .56194E-01 .70964E-03	-.39066E+00 -.20234E+00 -.78740E-01
10 19 216	.19725E+00 .15000E+01 .31567E+00	.15671E+00 .15000E+01 .32130E+00	.14215E+00 .16000E+01 .29146E+00	.17693E+00 .16000E+01 .26635E+00	.16869E+00 .15492E+01 .30393E+00	.13121E+00 .30093E+00 .94458E+00	.40929E-02 .56357E-01 .70622E-03	-.19497E+00 -.42991E+00 .37772E-01
11 18 217	.16920E+00 .14000E+01 .34690E+00	.12117E+00 .14000E+01 .35169E+00	.11222E+00 .15000E+01 .32592E+00	.15671E+00 .15000E+01 .32130E+00	.13989E+00 .14494E+01 .33607E+00	.99802E-01 .25848E+00 .96085E+00	.46145E-02 .56495E-01 .72194E-03	-.19566E+00 -.36409E+00 .35498E-01
11 19 218	.15671E+00 .15000E+01 .32130E+00	.11222E+00 .15000E+01 .32592E+00	.10160E+00 .16000E+01 .29505E+00	.14215E+00 .16000E+01 .29146E+00	.12832E+00 .15492E+01 .30803E+00	.98604E-01 .29770E+00 .94955E+00	.44674E-02 .56466E-01 .71696E-03	-.39025E+00 -.19956E+00 -.69416E-01
12 18 219	.12117E+00 .14000E+01 .35169E+00	.81890E-01 .14000E+01 .35472E+00	.75850E-01 .15000E+01 .32654E+00	.11222E+00 .15000E+01 .32592E+00	.97831E-01 .14494E+01 .34043E+00	.69452E-01 .25651E+00 .96404E+00	.39236E-02 .56123E-01 .65291E-03	-.36101E+00 -.19643E+00 -.39005E-01
12 19 220	.11222E+00 .15000E+01 .32592E+00	.75850E-01 .15000E+01 .32654E+00	.68800E-01 .16000E+01 .27802E+00	.10160E+00 .16000E+01 .29505E+00	.89738E-01 .15492E+01 .31228E+00	.66541E-01 .29550E+00 .95288E+00	.36401E-02 .56267E-01 .65276E-03	-.19431E+00 -.39218E+00 .15952E-01

M	X1	X2	X3	X4	XP	XN	A	C24
N	Y1	Y2	Y3	Y4	YP	YN	FL	C25
P	Z1	Z2	Z3	Z4	ZP	ZN	C21	C26
13	.81890E-01	.37460E-01	.34710E-01	.75000E-01	.57511E-01	.40424E-01	.44260E-02	-.19449E+00
18	.14000E+01	.14000E+01	.15000E+01	.15000E+01	.14494E+01	.25534E+00	.50622E-01	-.35132E+00
221	.35472E+00	.35692E+00	.33025E+00	.32594E+00	.34269E+00	.96601E+00	.60097E-03	.16687E-01
13	.75850E-01	.34710E-01	.31490E-01	.60000E-01	.52754E-01	.40050E-01	.41078E-02	-.37953E+00
19	.15000E+01	.15000E+01	.16000E+01	.16000E+01	.15492E+01	.29415E+00	.56562E-01	-.19507E+00
222	.32854E+00	.33026E+00	.29959E+00	.29602E+00	.31435E+00	.95492E+00	.67806E-03	-.30408E-01
14	.37460E-01	.00000E+00	.00000E+00	.34710E-01	.16056E-01	.12726E-01	.37330E-02	-.35092E+00
18	.14000E+01	.14000E+01	.15000E+01	.15000E+01	.14494E+01	.25473E+00	.54940E-01	-.19419E+00
223	.35658E+00	.35717E+00	.33072E+00	.33026E+00	.34383E+00	.96693E+00	.63305E-03	-.87129E-02
14	.34710E-01	.00000E+00	.00000E+00	.31490E-01	.16563E-01	.12559E-01	.34629E-02	-.19412E+00
19	.15000E+01	.15000E+01	.16000E+01	.16000E+01	.15492E+01	.29347E+00	.55046E-01	-.37944E+00
224	.33026E+00	.33072E+00	.30000E+00	.29959E+00	.31539E+00	.95569E+00	.63472E-03	-.33508E-02

SECTION 5

M	X1	X2	X3	X4	XP	XN	A	C24
N	Y1	Y2	Y3	Y4	YP	YN	FL	C25
P	Z1	Z2	Z3	Z4	ZP	ZN	C21	C26
1	.60000E+00	.55717E+00	.51552E+00	.52678E+00	.55615E+00	.79358E+00	.72619E-02	-.41274E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.56506E+00	.70838E-01	-.26529E+01
225	.00000E+00	.61710E-01	.54180E-01	.00000E+00	.29013E-01	.16496E+00	.36769E-02	.21348E+00
1	.52678E+00	.51552E+00	.42657E+00	.43569E+00	.47761E+00	.72918E+00	.67685E-02	-.28476E+01
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17464E+01	.66732E+00	.74249E-01	-.44160E+00
226	.00000E+00	.54180E-01	.44630E-01	.00000E+00	.24826E-01	.15157E+00	.36899E-02	-.58335E+00
2	.58717E+00	.54473E+00	.47826E+00	.51552E+00	.53217E+00	.69965E+00	.85615E-02	-.24380E+01
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.54332E+00	.77836E-01	-.55630E+00
227	.61710E-01	.12576E+00	.11042E+00	.54180E-01	.86141E-01	.46369E+00	.46531E-02	-.11760E+01
2	.51552E+00	.47826E+00	.39574E+00	.42657E+00	.45537E+00	.65022E+00	.78675E-02	-.38055E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17464E+01	.62560E+00	.80201E-01	-.28133E+01
228	.54180E-01	.11042E+00	.91360E-01	.44630E-01	.75421E-01	.43060E+00	.41750E-02	.10862E-01
3	.54473E+00	.49416E+00	.43366E+00	.47826E+00	.48844E+00	.57655E+00	.72224E-02	-.38253E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.46595E+00	.75582E-01	-.13406E+01
229	.12576E+00	.17015E+00	.14939E+00	.11042E+00	.13913E+00	.65665E+00	.25416E-02	.29720E+00
3	.47826E+00	.43366E+00	.35900E+00	.39574E+00	.41795E+00	.54303E+00	.65511E-02	-.13340E+01
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17464E+01	.56778E+00	.78098E-01	-.58871E+00
230	.11042E+00	.14939E+00	.12361E+00	.91360E-01	.11905E+00	.61866E+00	.24957E-02	-.97539E+00
4	.49416E+00	.42950E+00	.37709E+00	.43366E+00	.43426E+00	.46598E+00	.79160E-02	-.11346E+01
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.44268E+00	.77290E-01	-.51751E+00
231	.17015E+00	.20948E+00	.18392E+00	.14939E+00	.17849E+00	.76609E+00	.26776E-02	-.73560E+00
4	.43366E+00	.37709E+00	.31202E+00	.35900E+00	.37159E+00	.44315E+00	.71098E-02	-.33843E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17464E+01	.52221E+00	.78824E-01	-.14823E+01
232	.14939E+00	.18392E+00	.15218E+00	.12361E+00	.15273E+00	.72864E+00	.25247E-02	.17024E+00
5	.42950E+00	.37467E+00	.32912E+00	.37709E+00	.37818E+00	.37649E+00	.61743E-02	-.36081E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.41008E+00	.70871E-01	-.78660E+00
233	.20948E+00	.23424E+00	.20566E+00	.18392E+00	.20862E+00	.83071E+00	.17171E-02	.24283E+00
5	.37709E+00	.32912E+00	.27233E+00	.31202E+00	.32360E+00	.36051E+00	.55099E-02	-.78164E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17464E+01	.48716E+00	.72739E-01	-.49026E+00
234	.18392E+00	.20566E+00	.17017E+00	.15218E+00	.17651E+00	.79543E+00	.17257E-02	-.56879E+00
6	.37487E+00	.31522E+00	.27676E+00	.32912E+00	.32445E+00	.30617E+00	.64442E-02	-.66154E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.36900E+00	.70229E-01	-.42790E+00
235	.23424E+00	.25526E+00	.22411E+00	.20566E+00	.23014E+00	.86887E+00	.17135E-02	-.37396E+00
6	.32912E+00	.27676E+00	.22900E+00	.27233E+00	.27762E+00	.29441E+00	.57259E-02	-.33243E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17464E+01	.46403E+00	.71472E-01	-.88532E+00
236	.20566E+00	.22411E+00	.18544E+00	.17017E+00	.19693E+00	.83546E+00	.16943E-02	.18190E+00
7	.31522E+00	.26133E+00	.23598E+00	.27676E+00	.27436E+00	.24895E+00	.49291E-02	-.35317E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.37368E+00	.64672E-01	-.57506E+00
237	.25526E+00	.26533E+00	.23598E+00	.22411E+00	.24617E+00	.89344E+00	.13469E-02	.17659E+00

M	X1	X2	X3	X4	XP	XN	A	C24
N	Y1	Y2	Y3	Y4	YP	YN	FL	C25
P	Z1	Z2	Z3	Z4	ZP	ZN	C21	C26
7	.27676E+00	.23558E+00	.19494E+00	.22960E+00	.23477E+00	.24014E+00	.43675E-02	-.59891E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17464E+01	.44721E+00	.66230E-01	-.41811E+00
238	.22411E+00	.23558E+00	.19494E+00	.16544E+00	.21064E+00	.86159E+00	.13816E-02	-.34490E+00
8	.26833E+00	.22518E+00	.19770E+00	.23558E+00	.23202E+00	.20516E+00	.44606E-02	-.52565E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16489E+01	.36432E+00	.62397E-01	-.38590E+00
239	.26833E+00	.27807E+00	.24414E+00	.23558E+00	.25669E+00	.90839E+00	.12747E-02	-.21773E+00
8	.23558E+00	.19770E+00	.16359E+00	.19494E+00	.19654E+00	.19813E+00	.39455E-02	-.33818E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17464E+01	.43654E+00	.63854E-01	-.65205E+00
240	.23558E+00	.24414E+00	.20201E+00	.19494E+00	.21982E+00	.87760E+00	.13097E-02	.14752E+00
9	.22518E+00	.17893E+00	.15710E+00	.19770E+00	.16999E+00	.16463E+00	.47231E-02	-.35256E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.35692E+00	.61939E-01	-.48431E+00
241	.27807E+00	.25635E+00	.25141E+00	.24414E+00	.26537E+00	.91951E+00	.12570E-02	.12615E+00
9	.19770E+00	.15710E+00	.12999E+00	.16359E+00	.16258E+00	.15931E+00	.41723E-02	-.52555E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17484E+01	.42837E+00	.63025E-01	-.38141E+00
242	.24414E+00	.25141E+00	.20803E+00	.20201E+00	.22707E+00	.88945E+00	.12890E-02	-.21533E+00
10	.17893E+00	.14215E+00	.12461E+00	.15710E+00	.15096E+00	.12874E+00	.37251E-02	-.46205E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16489E+01	.35160E+00	.56857E-01	-.36436E+00
243	.28635E+00	.29146E+00	.25589E+00	.25141E+00	.27166E+00	.92725E+00	.11574E-02	-.12422E+00
10	.15710E+00	.12461E+00	.10327E+00	.12999E+00	.12918E+00	.12461E+00	.32875E-02	-.34394E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17484E+01	.42232E+00	.60149E-01	-.54853E+00
244	.25141E+00	.25589E+00	.21174E+00	.20803E+00	.23246E+00	.89764E+00	.12006E-02	.10442E+00
11	.14215E+00	.10160E+00	.89360E-01	.12461E+00	.11470E+00	.96841E-01	.40640E-02	-.35142E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16489E+01	.34800E+00	.56740E-01	-.43715E+00
245	.29146E+00	.29565E+00	.25957E+00	.25589E+00	.27603E+00	.93248E+00	.11627E-02	.77009E-01
11	.12461E+00	.89360E-01	.73960E-01	.10327E+00	.98146E-01	.93924E-01	.35841E-02	-.48862E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17484E+01	.41823E+00	.59739E-01	-.36125E+00
246	.25589E+00	.25957E+00	.21479E+00	.21174E+00	.23620E+00	.90347E+00	.12013E-02	-.12389E+00
12	.10180E+00	.63360E-01	.60410E-01	.89360E-01	.80210E-01	.67214E-01	.33110E-02	-.42960E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16489E+01	.34547E+00	.56721E-01	-.35415E+00
247	.29565E+00	.29802E+00	.26165E+00	.25957E+00	.27912E+00	.93602E+00	.11032E-02	-.62575E-01
12	.89360E-01	.60410E-01	.44960E-01	.73960E-01	.66636E-01	.65114E-01	.29191E-02	-.34780E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17484E+01	.41534E+00	.57893E-01	-.49498E+00
248	.25957E+00	.26165E+00	.21651E+00	.21479E+00	.23664E+00	.90733E+00	.11496E-02	.54249E-01
13	.68800E-01	.31490E-01	.27650E-01	.60410E-01	.47154E-01	.39497E-01	.37352E-02	-.35120E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.16469E+01	.34398E+00	.56828E-01	-.42177E+00
249	.29802E+00	.29959E+00	.26303E+00	.26165E+00	.28097E+00	.93814E+00	.11261E-02	.33550E-01
13	.66410E-01	.27650E-01	[illegible]	.44730E-01	.46550E-01	.36132E-01	.32917E-02	-.47254E+00
22	.17000E+01	.17000E+01	.16000E+01	.16000E+01	.17484E+01	.41370E+00	.57761E-01	-.35218E+00
250	.26165E+00	.26303E+00	.21764E+00	.21651E+00	.24042E+00	.90961E+00	.11673E-02	-.45454E-01

M	X1	X2	X3	X4	XP	XN	A	C24
N	Y1	Y2	Y3	Y4	YP	YN	FL	C25
P	Z1	Z2	Z3	Z4	ZP	ZN	C21	C26

14	.31490E-01	[illegible]	.00000E+00	.27656E-01	.14860E-01	.12228E-01	.31492E-02	-.42060E+00
21	.16000E+01	.16000E+01	.17000E+01	.17000E+01	.15460E+01	.34321E+00	.55457E-01	-.35100E+00
251	.25959E+00	.30000E+00	.25537E+00	.25303E+00	.26190E+00	.93918E+00	.10870E-02	-.11407E-01

14	.27650E-01	.00000E+00	.00000E+00	.22565E-01	.12670E-01	.11397E-01	.27754E-02	-.35054E+00
22	.17000E+01	.17000E+01	.18000E+01	.18000E+01	.17464E+01	.41288E+00	.56563E-01	-.47263E+00
252	.20303E+00	.20359E+00	.21794E+00	.21764E+00	.24121E+00	.91071E+00	.11339E-02	.69129E-02

1	.43569E+00	.42657E+00	.30557E+00	.31225E+00	.37344E+00	.62525E+00	.61704E-02	-.85412E+00
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.76952E+00	.83668E-01	-.31933E+01
253	.00000E+00	.44830E-01	.32120E-01	.00000E+00	.19413E-01	.13000E+00	.65178E-02	.39267E+00

QUESTIONABLE POINT -POOR FIT .639E-02
WARNING LONG THIN QUAD.

1	.31225E+00	.30557E+00	.00000E+00	.00000E+00	.20594E+00	.38257E+00	.52762E-02	-.32826E+01
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.91936E+00	.16336E+00	-.85409E+00
254	.00000E+00	.32120E-01	.00000E+00	.00000E+00	.10707E-01	.91715E-01	.19002E-01	-.80341E+00

2	.42657E+00	.39574E+00	.28349E+00	.30557E+00	.35606E+00	.56715E+00	.70461E-02	-.27613E+01
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.73290E+00	.87888E-01	-.12693E+01
255	.44830E-01	.91300E-01	.65450E-01	.32120E-01	.58972E-01	.37576E+00	.66946E-02	-.18141E+01

QUESTIONABLE POINT -POOR FIT .191E-01
WARNING LONG THIN QUAD.

2	.30557E+00	.28349E+00	.00000E+00	.00000E+00	.19635E+00	.34782E+00	.58022E-02	-.79667E+00
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.89683E+00	.16106E+00	-.32434E+01
256	.32120E-01	.65450E-01	.00000E+00	.00000E+00	.32523E-01	.27334E+00	.16190E-01	-.12984E+00

3	.39574E+00	.35900E+00	.25717E+00	.28349E+00	.32660E+00	.48421E+00	.57441E-02	-.10060E+01
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.67912E+00	.85453E-01	-.20081E+01
257	.91300E-01	.12361E+00	.86550E-01	.65450E-01	.93082E-01	.55166E+00	.61126E-02	.94204E+00

QUESTIONABLE POINT -POOR FIT .116E-01
WARNING LONG THIN QUAD.

3	.28349E+00	.25717E+00	.00000E+00	.00000E+00	.18022E+00	.30112E+00	.44910E-02	-.16725E+01
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.86851E+00	.15335E+00	-.14187E+01
258	.65450E-01	.86550E-01	[illegible]	.00000E+00	.51333E-01	.39372E+00	.16502E-01	-.15017E+01

4	.35900E+00	.31202E+00	.22352E+00	.25717E+00	.29055E+00	.40167E+00	.61282E-02	-.14007E+01
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.63397E+00	.84509E-01	-.16088E+01
259	.12361E+00	.15218E+00	.10902E+00	.86550E-01	.11942E+00	.66074E+00	.62780E-02	-.13163E+01

QUESTIONABLE POINT -POOR FIT .116E-01
WARNING LONG THIN QUAD.

4	.25717E+00	.22352E+00	.00000E+00	.00000E+00	.16023E+00	.25090E+00	.45683E-02	-.84137E+00
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.84293E+00	.14446E+00	-.21728E+01
260	.86550E-01	.10902E+00	.00000E+00	.00000E+00	.65857E-01	.47595E+00	.15315E-01	.48765E+00

5	.31202E+00	.27233E+00	.19509E+00	.22352E+00	.25302E+00	.33089E+00	.46933E-02	-.12347E+01
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.59760E+00	.78404E-01	-.13134E+01
261	.15218E+00	.17017E+00	.12190E+00	.10902E+00	.13958E+00	.73017E+00	.59601E-02	.10825E+01

M / N / P	X1 / Y1 / Z1	X2 / Y2 / Z2	X3 / Y3 / Z3	X4 / Y4 / Z4	XP / YP / ZP	XN / YN / ZN	A / FL / C21	C24 / C25 / C26
QUESTIONABLE POINT -POOR FIT		[illegible]E-02						
WARNING LONG THIN QUAD.								
5	.22352E+00	.19509E+00	.00000E+00	.00000E+00	.15954E+00	.21010E+00	.33720E-02	-.10049E+01
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.82529E+00	.13359E+00	-.15428E+01
262	.10902E+00	.12190E+00	.00000E+00	.00000E+00	.76973E-01	.52417E+00	.14192E-01	-.92873E+00
6	.27233E+00	.22900E+00	.16405E+00	.19509E+00	.21706E+00	.27236E+00	.46399E-02	-.88779E+00
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.57322E+00	.76021E-01	-.16604E+01
263	.17017E+00	.13544E+00	.13264E+00	.12190E+00	.15398E+00	.77261E+00	.60364E-02	-.72763E+00
QUESTIONABLE POINT -POOR FIT		.506E-02						
WARNING LONG THIN QUAD.								
6	.19509E+00	.16405E+00	.00000E+00	.00000E+00	.11971E+00	.17371E+00	.33858E-02	-.98461E+00
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.81220E+00	.12500E+00	-.15340E+01
264	.12190E+00	.13264E+00	.00000E+00	.00000E+00	.84913E-01	.55691E+00	.13517E-01	.87257E+00
QUESTIONABLE POINT -POOR FIT		.743E-04						
7	.22900E+00	.19494E+00	.13964E+00	.16405E+00	.16356E+00	.22337E+00	.36721E-02	-.14317E+01
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.55507E+00	.70855E-01	-.95446E+00
265	.16544E+00	.19494E+00	.13964E+00	.13264E+00	.16470E+00	.80125E+00	.59185E-02	.96667E+00
QUESTIONABLE POINT -POOR FIT		.663E-02						
WARNING LONG THIN QUAD.								
7	.16405E+00	.13964E+00	.00000E+00	.00000E+00	.10123E+00	.14384E+00	.25206E-02	-.77595E+00
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.80313E+00	.11636E+00	-.15619E+01
266	.13264E+00	.13964E+00	.00000E+00	.00000E+00	.90827E-01	.57818E+00	.12962E-01	-.57432E+00
QUESTIONABLE POINT -POOR FIT		.792E-04						
8	.19494E+00	.16359E+00	.11719E+00	.13964E+00	.15524E+00	.18460E+00	.33058E-02	-.70620E+00
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.54326E+00	.68130E-01	-.16820E+01
267	.19494E+00	.20201E+00	.14471E+00	.13964E+00	.17168E+00	.81897E+00	.59179E-02	-.44064E+00
QUESTIONABLE POINT -POOR FIT		.581E-02						
WARNING LONG THIN QUAD.								
8	.13964E+00	.11719E+00	.00000E+00	.00000E+00	.85610E-01	.11965E+00	.22397E-02	-.11754E+01
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.79705E+00	.11024E+00	-.11506E+01
268	.13964E+00	.14471E+00	.00000E+00	.00000E+00	.94783E-01	.59194E+00	.12624E-01	.95666E+00
QUESTIONABLE POINT -POOR FIT		.974E-04						
9	.16359E+00	.12999E+00	.93120E-01	.11719E+00	.12712E+00	.14906E+00	.34872E-02	-.15705E+01
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.53415E+00	.66657E-01	-.74424E+00
269	.20201E+00	.20803E+00	.14902E+00	.14471E+00	.17754E+00	.83214E+00	.59462E-02	.73356E+00
QUESTIONABLE POINT -POOR FIT		.630E-02						
WARNING LONG THIN QUAD.								
9	.11719E+00	.93120E-01	.00000E+00	.00000E+00	.70103E-01	.96709E-01	.23391E-02	-.68292E+00
24	.19000E+01	.19000E+01	.20000E+01	.20000E+01	.19333E+01	.79230E+00	.10524E+00	-.15648E+01
270	.14471E+00	.14902E+00	.00000E+00	.00000E+00	.97910E-01	.60242E+00	.12379E-01	-.36261E+00
QUESTIONABLE POINT -POOR FIT		.350E-04						
10	.12999E+00	.10327E+00	.73960E-01	.93120E-01	.10100E+00	.11689E+00	.27426E-02	-.62316E+00
23	.18000E+01	.18000E+01	.19000E+01	.19000E+01	.18472E+01	.52744E+00	.63857E-01	-.16921E+01
271	.20803E+00	.21174E+00	.15166E+00	.14902E+00	.16176E+00	.84151E+00	.59113E-02	-.25950E+00

```
 M       X1            X2            X3            X4            XP            XN            A             C24
 N       Y1            Y2            Y3            Y4            YP            YN            FL            C25
 P       Z1            Z2            Z3            Z4            ZP            ZN            C21           C26

QUESTIONABLE POINT -POOR FIT       .627E-02
WARNING LONG THIN QUAD.
 10    .93120E-01    .73760E-01    .30000E+00    .00000E+00    .55700E-01    .70365E-01    .16265E-02   -.13555E+01
 24    .19000E+01    .19000E+01    .20000E+01    .20000E+01    .19333E+01    .76869E+00    .10064E+00   -.88654E+00
272    .14902E+00    .15168E+00    .00000E+00    .00000E+00    .10023E+00    .60976E+00    .12173E-01    .82197E+00

QUESTIONABLE POINT -POOR FIT       .765E-04
 11    .10327E+00    .73960E-01    .52900E-01    .73960E-01    .70740E-01    .66139E-01    .29660E-02   -.16551E+01
 23    .18000E+01    .18000E+01    .19000E+01    .19000E+01    .18472E+01    .52268E+00    .63003E-01   -.62401E+00
273    .21174E+00    .21479E+00    .15386E+00    .15168E+00    .18468E+00    .84764E+00    .59326E-02    .44811E+00

QUESTIONABLE POINT -POOR FIT       .690E-02
WARNING LONG THIN QUAD.
 11    .73960E-01    .52960E-01    .00000E+00    .00000E+00    .42320E-01    .57505E-01    .19784E-02   -.62834E+00
 24    .19000E+01    .19000E+01    .20000E+01    .20000E+01    .19333E+01    .76645E+00    .97626E-01   -.15660E+01
274    .15168E+00    .15386E+00    .00000E+00    .00000E+00    .10165E+00    .61497E+00    .12051E-01   -.20562E+00

QUESTIONABLE POINT -POOR FIT       .893E-04
 12    .73960E-01    .49960E-01    .35810E-01    .52960E-01    .53667E-01    .61297E-01    .24301E-02   -.58241E+00
 23    .18000E+01    .18000E+01    .19000E+01    .19000E+01    .18472E+01    .51963E+00    .61271E-01   -.16979E+01
275    .21479E+00    .21651E+00    .15510E+00    .15386E+00    .18675E+00    .85219E+00    .59100E-02   -.13373E+00

QUESTIONABLE POINT -POOR FIT       .617E-02
WARNING LONG THIN QUAD.
 12    .52960E-01    .35810E-01    .00000E+00    .00000E+00    .29597E-01    .40560E-01    .16042E-02   -.14894E+01
 24    .19000E+01    .19000E+01    .20000E+01    .20000E+01    .19333E+01    .76483E+00    .95034E-01   -.70207E+00
276    .15386E+00    .15510E+00    .00000E+00    .00000E+00    .10299E+00    .61839E+00    .11952E-01    .54270E+00

QUESTIONABLE POINT -POOR FIT       .914E-04
 13    .49960E-01    .22860E-01    .16390E-01    .35810E-01    .31549E-01    .35648E-01    .27385E-02   -.16950E+01
 23    .18000E+01    .18000E+01    .19000E+01    .19000E+01    .18472E+01    .51769E+00    .60826E-01   -.56850E+00
277    .21651E+00    .21764E+00    .15591E+00    .15510E+00    .18798E+00    .85482E+00    .59297E-02    .14975E+00

QUESTIONABLE POINT -POOR FIT       .576E-02
WARNING LONG THIN QUAD.
 13    .35810E-01    .16390E-01    .00000E+00    .00000E+00    .17400E-01    .22963E-01    .18046E-02   -.61982E+00
 24    .19000E+01    .19000E+01    .20000E+01    .20000E+01    .19333E+01    .78373E+00    .93525E-01   -.15663E+01
278    .15510E+00    .15591E+00    .00000E+00    .00000E+00    .10367E+00    .62068E+00    .11907E-01   -.78520E-01

QUESTIONABLE POINT -POOR FIT       .902E-04
 14    .22860E-01    .00000E+00    .00000E+00    .16390E-01    .99068E-02    .11119E-01    .23085E-02   -.56408E+00
 23    .18000E+01    .18000E+01    .19000E+01    .19000E+01    .18472E+01    .51673E+00    .59805E-01   -.16994E+01
279    .21764E+00    .21794E+00    .15612E+00    .15591E+00    .18860E+00    .85608E+00    .59098E-02   -.21115E-01

QUESTIONABLE POINT -POOR FIT       .587E-02
WARNING LONG THIN QUAD.
 14    .16390E-01    .00000E+00    .00000E+00    .00000E+00    .54633E-02    .73546E-02    .15194E-02   -.15587E+01
 24    .19000E+01    .19000E+01    .20000E+01    .20000E+01    .19333E+01    .78325E+00    .92502E-01   -.62676E+00
280    .15591E+00    .15612E+00    .00000E+00    .00000E+00    .10401E+00    .62166E+00    .11871E-01    .17925E+00
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M	X1	X2	X3	XN	XP	XN	A	CZ4
N	Y1	Y2	Y3	Y4	YP	YN	FL	CZ5
P	Z1	Z2	Z3	Z4	ZP	ZN	CZ1	CZ6

SOLID ANGLE = 12.566

XYZ POTENTIAL FLOW PROGRAM SECTION [illegible] VERSION [illegible]

SAMPLE PROBLEM TRIAXIAL ELLIPSOID

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XYZ POTENTIAL FLOW PROGRAM SECTION 3, VERSION 4

SAMPLE PROBLEM TRIAXIAL ELLIPSOID

 X VELOCITY=-1.0     Y VELOCITY=  .0     Z VELOCITY=  .0

ITERATION   SUM OF CHANGES          A            B1            B2
     1          .56652E+00
     2          .13219E+00
     3          .67071E-01
     4          .25186E-01
     5          .94774E-02
                                 .727E+00     .232E+00     .713E+00
     6          .35680E-02
     7          .13438E-02
     8          .50600E-03

 X VELOCITY=  .0     Y VELOCITY=-1.0     Z VELOCITY=  .0

ITERATION   SUM OF CHANGES          A            B1            B2
     1          .31142E+01
     2          .22740E+01
     3          .16621E+01
     4          .12150E+01
     5          .88820E+00
                                 .576E+00     .435E+00     .529E+00
     6          .64920E+00
     7          .47463E+00
     8          .34695E+00
     9          .25362E+00
    10          .18540E+00
                          A EXTRAPOLATION
                                 .576E+00     .469E+00     .404E+00
    11          .13003E-05

 X VELOCITY=  .0     Y VELOCITY=  .0     Z VELOCITY=-1.0

ITERATION   SUM OF CHANGES          A            B1            B2
     1          .15305E+02
     2          .34163E+01
     3          .75655E+00
     4          .16728E+00
     5          .36973E-01
                                 .128E+01    -.341E+00     .133E+01
     6          .81712E-02
     7          .18059E-02

XYZ POTENTIAL FLOW PROGRAM SECTION 4, VERSION 4
SAMPLE PROBLEM TRIAXIAL ELLIPSOID
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X FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
1	.96869	.04999	.05140	-.05745	.01695	.27520	.28104	.92068	.11624	.12E-04
2	.96621	.14997	.05127	-.05910	.05136	.27469	.28582	.91830	.11616	.12E-04
3	.94266	.04999	.15015	-.42322	.01309	.63655	.76618	.41297	.09881	.11E-04
4	.94030	.14997	.15574	-.42399	.03940	.63758	.76670	.41217	.09873	.11E-04
5	.86521	.04999	.24644	-.79585	.00860	.69827	1.05864	-.12072	.07488	.93E-05
6	.86304	.14997	.24562	-.79610	.02666	.69775	1.05893	-.12134	.07485	.93E-05
7	.76924	.04999	.31617	-1.02127	.00624	.62115	1.19535	-.42806	.05888	.74E-05
8	.76731	.14997	.31557	-1.02143	.01875	.62060	1.19548	-.42917	.05887	.74E-05
9	.66989	.04999	.36954	-1.10764	.00442	.52915	1.28213	-.64306	.04587	.62E-05
10	.66821	.14997	.36861	-1.10790	.01363	.52867	1.28213	-.64307	.04586	.62E-05
11	.57471	.04999	.40706	-1.24741	.00339	.43964	1.32262	-.74933	.03697	.50E-05
12	.57327	.14997	.40664	-1.24751	.01025	.43940	1.32267	-.74947	.03695	.50E-05
13	.48598	.04999	.43605	-1.30479	.00257	.36348	1.35446	-.83460	.02959	.41E-05
14	.48477	.14997	.43470	-1.30466	.00792	.36337	1.35436	-.83430	.02959	.41E-05
15	.41160	.04999	.45505	-1.33706	.00207	.30195	1.37073	-.87891	.02428	.34E-05
16	.40997	.14997	.45391	-1.33710	.00624	.30166	1.37070	-.87898	.02427	.34E-05
17	.33655	.04999	.47036	-1.35954	.00160	.24338	1.38116	-.90759	.01944	.27E-05
18	.33571	.14997	.46566	-1.35958	.00467	.24328	1.38116	-.90766	.01944	.27E-05
19	.26741	.04999	.46121	-1.37546	.00126	.19148	1.39170	-.93663	.01494	.22E-05
20	.26674	.14997	.46000	-1.37647	.00370	.19147	1.39171	-.93666	.01495	.22E-05
21	.20317	.04999	.48895	-1.38751	.00092	.14409	1.39497	-.94595	.01127	.17E-05
22	.20266	.14997	.48773	-1.38755	.00278	.14399	1.39501	-.94604	.01126	.17E-05
23	.14208	.04999	.49442	-1.39661	.00066	.10036	1.40021	-.96058	.00779	.12E-05
24	.14173	.14997	.49318	-1.39664	.00192	.10033	1.40024	-.96068	.00779	.12E-05
25	.08352	.04999	.49759	-1.39965	.00038	.05877	1.40088	-.96247	.00456	.67E-06
26	.08332	.14997	.49645	-1.39965	.00112	.05879	1.40088	-.96248	.00459	.67E-06
27	.02622	.04999	.49934	-1.40320	.00012	.01833	1.40332	-.96930	.00141	.21E-06
28	.02616	.14997	.49809	-1.40319	.00035	.01823	1.40331	-.96928	.00140	.22E-06
29	.98124	.24995	.05101	-.00246	.06555	.27423	.29397	.91358	.11600	.12E-04
30	.97372	.34993	.05062	-.00762	.11963	.27348	.30614	.90628	.11576	.12E-04
31	.93556	.24995	.15495	-.42622	.06572	.63609	.76899	.40865	.09865	.11E-04
32	.92839	.34992	.15377	-.42900	.09227	.63441	.77136	.40497	.09844	.10E-04
33	.85869	.24995	.24458	-.79701	.04450	.59676	1.05957	-.12268	.07480	.92E-05
34	.85211	.34992	.24271	-.79845	.06262	.69519	1.06053	-.12473	.07470	.92E-05
35	.76344	.24995	.31376	-1.02198	.03132	.62011	1.19581	-.42996	.05882	.74E-05
36	.75759	.34992	.31133	-1.02269	.04420	.61696	1.19622	-.43095	.05878	.73E-05
37	.66484	.24995	.36676	-1.10818	.02242	.52843	1.28234	-.64440	.04584	.62E-05
38	.65975	.34992	.36394	-1.10850	.03169	.52761	1.28249	-.64477	.04581	.62E-05
39	.57038	.24995	.40459	-1.24768	.01707	.43899	1.32277	-.74971	.03692	.50E-05
40	.56602	.34992	.40149	-1.24769	.02411	.43648	1.32291	-.75008	.03691	.50E-05
41	.48232	.24995	.43276	-1.30494	.01302	.36312	1.35459	-.83490	.02959	.41E-05
42	.47863	.34992	.42945	-1.30476	.01849	.36261	1.35436	-.83428	.02956	.41E-05
43	.40790	.24995	.45152	-1.33709	.01049	.30165	1.37073	-.87891	.02427	.34E-05
44	.40478	.34993	.44816	-1.33728	.01472	.30128	1.37068	-.87931	.02425	.34E-05
45	.33401	.24995	.46651	-1.35962	.00817	.24309	1.38120	-.90772	.01943	.27E-05
46	.33145	.34992	.46294	-1.35970	.01151	.24265	1.38126	-.90769	.01942	.27E-05
47	.26539	.24995	.47756	-1.37643	.00623	.19129	1.39165	-.93669	.01494	.22E-05
48	.26335	.34992	.47392	-1.37850	.00860	.19110	1.39179	-.93707	.01493	.22E-05
49	.20164	.24995	.48527	-1.38757	.00464	.14401	1.39503	-.94610	.01127	.16E-05
50	.20009	.34993	.48155	-1.38760	.00655	.14392	1.39505	-.94618	.01127	.16E-05

X FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
51	.14161	.24995	.49959	-1.37069	.00322	.10015	1.40028	-.96077	.00777	.12E-05
52	.13993	.34992	.45094	-1.39030	.00447	.10006	1.40039	-.96109	.00777	.12E-05
53	.06290	.24995	.49934	-1.39904	.00186	.05871	1.40087	-.96244	.00456	.67E-06
54	.06226	.34993	.49010	-1.39904	.00262	.05853	1.40087	-.96243	.00456	.67E-06
55	.02603	.24995	.49550	-1.40322	.00057	.01831	1.40334	-.96935	.00141	.21E-06
56	.02563	.34992	.49176	-1.40322	.00062	.01844	1.40335	-.96938	.00143	.21E-06
57	.96362	.44990	.05009	-.07409	.15469	.27254	.32266	.89627	.11582	.12E-04
58	.95084	.54988	.04943	-.08366	.17111	.27067	.34179	.88318	.11539	.12E-04
59	.91876	.44990	.15217	-.45373	.11924	.63257	.77620	.39752	.09824	.10E-04
60	.90657	.54988	.15016	-.45094	.14679	.62860	.78077	.39040	.09790	.10E-04
61	.84326	.44990	.24019	-.80346	.05106	.69310	1.06192	-.12768	.07459	.92E-05
62	.83263	.54988	.23700	-.80342	.15004	.69059	1.06379	-.13164	.07442	.91E-05
63	.74973	.44990	.30615	-1.02374	.05707	.61746	1.19690	-.43256	.05869	.73E-05
64	.73973	.54988	.30430	-1.02565	.07059	.61550	1.19773	-.43455	.05860	.73E-05
65	.65290	.44990	.36017	-1.16964	.04106	.52662	1.28284	-.64567	.04578	.61E-05
66	.64424	.54988	.35539	-1.16961	.05099	.52522	1.28314	-.64644	.04572	.61E-05
67	.56014	.44990	.39733	-1.24020	.03120	.43774	1.32310	-.75059	.03688	.49E-05
68	.55271	.54988	.39206	-1.24064	.03803	.43666	1.32336	-.75127	.03684	.49E-05
69	.47367	.44990	.42560	-1.30537	.02392	.36210	1.35487	-.83566	.02954	.41E-05
70	.46738	.54987	.41930	-1.30527	.02962	.36119	1.35465	-.83508	.02949	.41E-05
71	.40057	.44990	.44351	-1.33734	.01912	.30081	1.37069	-.87933	.02423	.34E-05
72	.39526	.54988	.45703	-1.33754	.02356	.30032	1.37105	-.87977	.02422	.34E-05
73	.32801	.44990	.45014	-1.35979	.01494	.24243	1.38132	-.90803	.01939	.27E-05
74	.32366	.54988	.45200	-1.35998	.01846	.24194	1.38146	-.90842	.01937	.27E-05
75	.26062	.44990	.46900	-1.37652	.01143	.19065	1.39171	-.93687	.01492	.22E-05
76	.25716	.54988	.46275	-1.37674	.01412	.19052	1.39191	-.93742	.01491	.22E-05
77	.19802	.44990	.47655	-1.38763	.00852	.14364	1.39507	-.94622	.01125	.16E-05
78	.19539	.54988	.47023	-1.38770	.01052	.14328	1.39511	-.94634	.01123	.16E-05
79	.13848	.44990	.46158	-1.39676	.00584	.10005	1.40035	-.96099	.00776	.11E-05
80	.13664	.54988	.47548	-1.39662	.00722	.09990	1.40041	-.96115	.00776	.11E-05
81	.08141	.44990	.46537	-1.39971	.00339	.05849	1.40094	-.96262	.00456	.67E-06
82	.08032	.54988	.47664	-1.39977	.00422	.05847	1.40100	-.96280	.00457	.66E-06
83	.02556	.44990	.46668	-1.40328	.00106	.01833	1.40340	-.96954	.00142	.21E-06
84	.02522	.54988	.46022	-1.40333	.00131	.01827	1.40344	-.96966	.00141	.21E-06
85	.93526	.64965	.04662	-.09550	.22607	.26790	.36451	.86713	.11487	.12E-04
86	.91676	.74962	.04766	-.10938	.26557	.26565	.39083	.84725	.11420	.12E-04
87	.89172	.64965	.14770	-.44606	.17503	.62502	.78757	.37974	.09796	.10E-04
88	.87408	.74962	.14477	-.45426	.20499	.61914	.79480	.36829	.09747	.10E-04
89	.81845	.64965	.23312	-.80662	.11936	.66713	1.06631	-.13703	.07421	.90E-05
90	.80226	.74962	.22851	-.81059	.14002	.66272	1.06901	-.14277	.07396	.90E-05
91	.72767	.64965	.29908	-1.02670	.08432	.61306	1.19876	-.43707	.05848	.72E-05
92	.71327	.74962	.29316	-1.02862	.09906	.60997	1.20015	-.44035	.05833	.71E-05
93	.63369	.64965	.34957	-1.17055	.06076	.52349	1.28371	-.64792	.04564	.60E-05
94	.62115	.74962	.34265	-1.17156	.07143	.52121	1.28425	-.64931	.04556	.60E-05
95	.54366	.64965	.38584	-1.24917	.04626	.43558	1.32368	-.75212	.03679	.49E-05
96	.53290	.74962	.37801	-1.24980	.05420	.43376	1.32404	-.75308	.03673	.49E-05
97	.45973	.64965	.41249	-1.30575	.03541	.36039	1.35523	-.83666	.02947	.40E-05
98	.45063	.74962	.40433	-1.30599	.04158	.35910	1.35510	-.83629	.02942	.40E-05
99	.38879	.64965	.43046	-1.33707	.02826	.29944	1.37107	-.87983	.02417	.33E-05
100	.38110	.74962	.42144	-1.33610	.03308	.29842	1.37137	-.88066	.02413	.33E-05

X FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
101	.31855	.64965	.44460	-1.35617	.02215	.24140	1.38160	-.90862	.01936	.27E-05
102	[illegible]	.74962	[illegible]	-1.35532	.02595	.24071	1.38170	-.90968	.01934	.27E-05
103	.25275	.64965	[illegible]	-1.37570	.01692	.19064	1.39169	-.93737	.01489	.22E-05
104	.24795	.74962	.44620	-1.37966	.01962	.16946	1.39216	-.93811	.01486	.22E-05
105	.19219	.64965	.40253	-1.38770	.01259	.14295	1.39516	-.94648	.01121	.16E-05
106	.16839	.74962	.45556	-1.38706	.01479	.14256	1.39526	-.94675	.01120	.16E-05
107	.13440	.64965	.40770	-1.37664	.00866	.09973	1.40042	-.96118	.00776	.11E-05
108	.13175	.74962	.45645	-1.39698	.01016	.09943	1.40055	-.96155	.00777	.11E-05
109	.07961	.64965	.47066	-1.39966	.00504	.05826	1.40166	-.96302	.00455	.66E-06
110	.07745	.74962	.46149	-1.39995	.00593	.05819	1.40117	-.96327	.00456	.65E-06
111	.02461	.64965	.47236	-1.40336	.00160	.01825	1.40346	-.96976	.00141	.21E-06
112	.02432	.74962	.46362	-1.40347	.00164	.01814	1.40359	-.97065	.00140	.21E-06
113	.89515	.84978	.04653	-.12654	.30407	.26171	.42067	.82304	.11342	.12E-04
114	.87019	.94974	.04524	-.14746	.34376	.25611	.45444	.79348	.11278	.11E-04
115	.85347	.84978	.14136	-.40493	.23565	.61315	.60459	.35264	.09697	.99E-05
116	.82968	.94974	.13742	-.47722	.20672	.60458	.61505	.33570	.09624	.98E-05
117	.78335	.84978	.22312	-.81543	.16071	.67753	1.07229	-.14980	.07368	.89E-05
118	.76151	.94974	.21690	-.82122	.13299	.67080	1.07604	-.15706	.07355	.87E-05
119	.69646	.84978	.26625	-1.03132	.11363	.60619	1.20166	-.44404	.05813	.71E-05
120	.67704	.94974	.27627	-1.03460	.12983	.60158	1.20381	-.44915	.05791	.70E-05
121	.60651	.84978	.33458	-1.17262	.05217	.51846	1.28493	-.65106	.04543	.59E-05
122	.58960	.94974	.32525	-1.17444	.09391	.51510	1.28587	-.65346	.04528	.59E-05
123	.52034	.84978	.30910	-1.25058	.06260	.43177	1.32450	-.75430	.03664	.46E-05
124	.50563	.94974	.33361	-1.25155	.07149	.42929	1.32506	-.75578	.03656	.46E-05
125	.44001	.84978	.39450	-1.30691	.04796	.35763	1.35581	-.83822	.02936	.40E-05
126	.42774	.94974	.30379	-1.30720	.05472	.35571	1.35564	-.83830	.02926	.39E-05
127	.37211	.84978	.41250	-1.33651	.03826	.29733	1.37146	-.88094	.02409	.33E-05
128	.36174	.94974	.40051	-1.33862	.04366	.29590	1.37182	-.88190	.02404	.33E-05
129	.30471	.84978	.42559	-1.36070	.02998	.23966	1.38200	-.90994	.01931	.26E-05
130	.29621	.94975	.41372	-1.36100	.03424	.23870	1.38219	-.91046	.01926	.26E-05
131	.24210	.84978	.43566	-1.37969	.02291	.16868	1.39212	-.93800	.01482	.21E-05
132	.23535	.94974	.42353	-1.37946	.02616	.16766	1.39244	-.93890	.01478	.21E-05
133	.18395	.84978	.44269	-1.38801	.01707	.14212	1.39537	-.94706	.01119	.16E-05
134	.17832	.94974	.43035	-1.38817	.01952	.14152	1.39550	-.94742	.01117	.16E-05
135	.12864	.84978	.44764	-1.39762	.01171	.09899	1.40058	-.96161	.00774	.11E-05
136	.12505	.94975	.43516	-1.39726	.01338	.09870	1.40061	-.96226	.00774	.11E-05
137	.07562	.84978	.45061	-1.40064	.00664	.05804	1.40126	-.96354	.00456	.65E-06
138	.07352	.94974	.43805	-1.40022	.00753	.05769	1.40143	-.96401	.00453	.64E-06
139	.02374	.84978	.45210	-1.40354	.00215	.01807	1.40366	-.97027	.00140	.21E-06
140	.02308	.94974	.43949	-1.40364	.00240	.01792	1.40375	-.97052	.00138	.21E-06
141	.84159	1.04970	.04375	-.17276	.35576	.25266	.49243	.75751	.11160	.11E-04
142	.80896	1.14964	.04205	-.20339	.42827	.24698	.53459	.71422	.11016	.11E-04
143	.80241	1.04970	.13290	-.49279	.30004	.59523	.82696	.31283	.09544	.97E-05
144	.77130	1.14964	.12775	-.51100	.33453	.56253	.84403	.26762	.09440	.95E-05
145	.73648	1.04970	.20977	-.82644	.20604	.66257	1.08075	-.16801	.07311	.86E-05
146	.70793	1.14964	.20164	-.83718	.23190	.65229	1.08633	-.18012	.07275	.84E-05
147	.65479	1.04970	.26912	-1.03817	.14646	.59578	1.20590	-.45420	.05783	.69E-05
148	.62940	1.14964	.25869	-1.04369	.16516	.58859	1.20903	-.46176	.05749	.66E-05
149	.57022	1.04970	.31496	-1.17656	.10664	.51108	1.28715	-.65675	.04510	.56E-05
150	.54811	1.14964	.30236	-1.17921	.11970	.50565	1.28861	-.66053	.04499	.57E-05

SAMPLE PROBLEM TRIAXIAL ELLIPSOID PAGE = 4

X FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
151	.48921	1.04970	.34701	-1.25273	.00076	.42023	1.32572	-.75752	.03053	.47E-05
152	.47024	1.14964	.33530	-1.25440	.09145	.42243	1.32077	-.76032	.03039	.40E-05
153	.41363	1.04970	.37110	-1.30629	.00210	.35301	1.35060	-.84052	.02921	.39E-05
154	.39765	1.14964	.35079	-1.33710	.07017	.35004	1.35700	-.84161	.02916	.38E-05
155	.34965	1.04970	.36735	-1.33950	.04950	.29401	1.37220	-.88316	.02398	.32E-05
156	.33629	1.14964	.37233	-1.34022	.05604	.29176	1.37270	-.88446	.02390	.32E-05
157	.28647	1.04970	.40012	-1.30149	.03881	.23732	1.38256	-.91147	.01920	.26E-05
158	.27537	1.14964	.36401	-1.30195	.04306	.23558	1.38267	-.91233	.01917	.25E-05
159	.22762	1.04970	.40961	-1.37964	.02969	.16604	1.39255	-.93919	.01475	.21E-05
160	.21879	1.14964	.39373	-1.30016	.03357	.16557	1.39298	-.94039	.01472	.21E-05
161	.17294	1.04970	.41620	-1.30642	.02211	.14061	1.39571	-.94801	.01115	.16E-05
162	.16624	1.14964	.40007	-1.33602	.02565	.13964	1.39607	-.94902	.01113	.15E-05
163	.12094	1.04970	.42066	-1.39743	.01522	.09815	1.40095	-.96266	.00772	.11E-05
164	.11625	1.14964	.40494	-1.39775	.01717	.09737	1.40124	-.96348	.00768	.11E-05
165	.07110	1.04970	.42365	-1.40039	.00867	.05740	1.40159	-.96447	.00452	.64E-06
166	.06834	1.14964	.40723	-1.40063	.01002	.05704	1.40183	-.96512	.00452	.63E-06
167	.02232	1.04970	.42505	-1.40379	.00276	.01781	1.40390	-.97095	.00138	.20E-06
168	.02146	1.14964	.40857	-1.40405	.00310	.01778	1.40417	-.97169	.00139	.20E-06
169	.77179	1.24957	.04012	-.24063	.47261	.23847	.58174	.66158	.10836	.11E-04
170	.72939	1.34948	.03791	-.26740	.51647	.22967	.63574	.59564	.10613	.10E-04
171	.73567	1.24957	.12108	-.53454	.37144	.56808	.86596	.25358	.09345	.92E-05
172	.69544	1.34948	.11516	-.56339	.41047	.54869	.88723	.21263	.09187	.90E-05
173	.67540	1.24957	.17238	-.84840	.25922	.63960	1.09365	-.19606	.07205	.82E-05
174	.63829	1.34948	.16161	-.86266	.26863	.62361	1.10366	-.21673	.07116	.80E-05
175	.60049	1.24957	.24661	-1.04662	.16516	.57930	1.21239	-.46968	.05721	.66E-05
176	.56749	1.34948	.23325	-1.05654	.20759	.56747	1.21712	-.48138	.05665	.65E-05
177	.52293	1.24957	.26847	-1.16264	.13470	.49920	1.29016	-.66457	.04471	.56E-05
178	.49420	1.34948	.27262	-1.16619	.15146	.49071	1.29256	-.67077	.04450	.55E-05
179	.44864	1.24957	.31323	-1.25636	.10266	.41755	1.32792	-.76338	.03630	.45E-05
180	.42399	1.34948	.30075	-1.25903	.11616	.41112	1.32954	-.76768	.03605	.44E-05
181	.37938	1.24957	.34039	-1.31059	.07926	.34695	1.35606	-.84431	.02903	.38E-05
182	.35853	1.34948	.32169	-1.31220	.08956	.34210	1.35901	-.84691	.02894	.37E-05
183	.32084	1.24957	.35522	-1.34114	.06326	.28892	1.37337	-.88613	.02385	.31E-05
184	.30321	1.34948	.33570	-1.34245	.07183	.28515	1.37426	-.88863	.02362	.31E-05
185	.26272	1.24957	.36694	-1.36265	.04969	.23342	1.38339	-.91377	.01911	.25E-05
186	.24828	1.34948	.34678	-1.36332	.05645	.23033	1.38379	-.91487	.01905	.25E-05
187	.20874	1.24957	.37564	-1.36061	.03799	.18367	1.39332	-.94135	.01469	.20E-05
188	.19728	1.34948	.35500	-1.36110	.04326	.18156	1.39366	-.94228	.01462	.20E-05
189	.15860	1.24957	.36169	-1.38925	.02837	.13653	1.39643	-.95000	.01109	.15E-05
190	.14989	1.34948	.36072	-1.36961	.03217	.13665	1.39670	-.95078	.01104	.15E-05
191	.11091	1.24957	.36595	-1.39866	.01941	.09646	1.40152	-.96425	.00766	.11E-05
192	.10482	1.34948	.36475	-1.39635	.02217	.09542	1.40177	-.96497	.00765	.10E-05
193	.06520	1.24957	.36631	-1.40065	.01136	.05648	1.40204	-.96570	.00450	.62E-06
194	.06162	1.34948	.36717	-1.40115	.01290	.05573	1.40232	-.96650	.00447	.61E-06
195	.02047	1.24957	.36960	-1.40434	.00353	.01782	1.40446	-.97250	.00142	.19E-06
196	.01935	1.34948	.36838	-1.40460	.00408	.01758	1.40471	-.97342	.00141	.19E-06
197	.68077	1.44936	.03539	-.34563	.56531	.21715	.69737	.51367	.10325	.10E-04
198	.62447	1.54919	.03246	-.42124	.61174	.20206	.76974	.40750	.09945	.97E-05
199	.64968	1.44936	.10751	-.60077	.45152	.52523	.91687	.15935	.08984	.88E-05
200	.59540	1.54919	.09861	-.64951	.49436	.49355	.95386	.09015	.08708	.85E-05

X FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
201	.59574	1.44936	.16909	-.80159	.32142	.60227	1.11485	-.24290	.07001	.76E-05
202	.54647	1.54919	.15566	-.90550	.35603	.57393	1.13069	-.27846	.06642	.76E-05
203	.52966	1.44937	.21770	-1.00031	.25262	.55163	1.22268	-.49542	.05593	.63E-05
204	.48566	1.54919	.17769	-1.07457	.26670	.53027	1.23165	-.51546	.05488	.62E-05
205	.46126	1.44936	.25435	-1.13132	.17671	.47719	1.29536	-.67602	.04406	.54E-05
206	.42311	1.54919	.23340	-1.17623	.17253	.46324	1.29960	-.68741	.04343	.52E-05
207	.39572	1.44936	.26670	-1.20192	.15115	.40240	1.33100	-.77157	.03573	.44E-05
208	.36360	1.54919	.25749	-1.26671	.14600	.39048	1.33383	-.77911	.03527	.43E-05
209	.33463	1.44936	.30024	-1.31423	.10143	.33549	1.36016	-.85005	.02871	.36E-05
210	.30696	1.54919	.27542	-1.31676	.11530	.32642	1.36170	-.85423	.02839	.36E-05
211	.26300	1.44936	.31332	-1.34363	.08134	.27996	1.37489	-.89033	.02346	.31E-05
212	.25959	1.54919	.26741	-1.34499	.09247	.27251	1.37543	-.89161	.02296	.31E-05
213	.23173	1.44936	.32366	-1.36365	.06408	.22619	1.38397	-.91536	.01868	.25E-05
214	.21257	1.54919	.27669	-1.35421	.07278	.22052	1.38383	-.91500	.01850	.25E-05
215	.18412	1.44936	.33133	-1.36065	.04896	.17641	1.39316	-.94096	.01452	.20E-05
216	.16869	1.54919	.30373	-1.36122	.05568	.17406	1.39327	-.94120	.01440	.19E-05
217	.13969	1.44936	.33667	-1.36958	.03649	.13452	1.39656	-.95037	.01097	.15E-05
218	.12832	1.54919	.30653	-1.36961	.04164	.13127	1.39661	-.95053	.01087	.14E-05
219	.09783	1.44936	.34043	-1.39845	.02491	.09412	1.40183	-.96514	.00762	.10E-05
220	.08974	1.54919	.31228	-1.39836	.02806	.09170	1.40168	-.96471	.00754	.10E-05
221	.05751	1.44936	.34269	-1.40123	.01457	.05479	1.40236	-.96666	.00443	.60E-06
222	.05275	1.54919	.31435	-1.40112	.01673	.05361	1.40225	-.96629	.00442	.59E-06
223	.01806	1.44936	.34363	-1.40404	.00451	.01730	1.40470	-.97334	.00139	.19E-06
224	.01656	1.54919	.31539	-1.40438	.00519	.01606	1.40469	-.97315	.00138	.19E-06
225	.55815	1.64892	.02901	-.52078	.65434	.16219	.85590	.26744	.09427	.92E-05
226	.47761	1.74843	.02463	-.65754	.66342	.15452	.96089	.07670	.08659	.85E-05
227	.53217	1.64892	.00614	-.71660	.55708	.45135	1.00241	-.00483	.08323	.81E-05
228	.45537	1.74843	.07542	-.81046	.57323	.39132	1.06742	-.13938	.07736	.76E-05
229	.46844	1.64892	.13913	-.94164	.39519	.53435	1.15272	-.32877	.06619	.73E-05
230	.41795	1.74843	.11905	-.97523	.43408	.47519	1.18520	-.40470	.06255	.69E-05
231	.43426	1.64892	.17849	-1.07945	.29263	.49954	1.24262	-.54409	.05342	.60E-05
232	.37159	1.74843	.15273	-1.13024	.32768	.45257	1.26081	-.56963	.05099	.57E-05
233	.37818	1.64892	.20652	-1.20934	.21614	.44041	1.30539	-.70405	.04244	.51E-05
234	.32360	1.74843	.17891	-1.22723	.24769	.40441	1.31570	-.73168	.04076	.49E-05
235	.32445	1.64892	.23014	-1.27326	.16928	.37263	1.33750	-.78869	.03459	.42E-05
236	.27762	1.74843	.19633	-1.28491	.19401	.34504	1.34450	-.80769	.03336	.40E-05
237	.27436	1.64892	.24617	-1.32067	.13174	.31292	1.36381	-.85998	.02772	.35E-05
238	.23477	1.74842	.21004	-1.32721	.15197	.29104	1.36722	-.86929	.02642	.36E-05
239	.23202	1.64892	.25639	-1.34764	.10567	.26177	1.37632	-.89425	.02260	.30E-05
240	.19854	1.74843	.21962	-1.35071	.12297	.24377	1.37603	-.89896	.02186	.30E-05
241	.18999	1.64892	.26537	-1.36552	.06368	.21201	1.38441	-.91660	.01821	.24E-05
242	.16258	1.74843	.22707	-1.36756	.09726	.19811	1.38525	-.91892	.01768	.24E-05
243	.15096	1.64872	.27106	-1.36169	.06426	.16747	1.39329	-.94125	.01417	.19E-05
244	.12918	1.74843	.23246	-1.38291	.07477	.15677	1.39378	-.94261	.01375	.19E-05
245	.11470	1.64892	.27603	-1.38963	.04806	.12640	1.39639	-.94992	.01072	.14E-05
246	.09815	1.74842	.23620	-1.39045	.05666	.11860	1.39662	-.95055	.01043	.14E-05
247	.06021	1.64872	.27912	-1.39809	.03298	.08822	1.40125	-.96351	.00741	.10E-05
248	.06864	1.74843	.23364	-1.39827	.03649	.08273	1.40125	-.96350	.00719	.98E-06
249	.04715	1.64892	.26097	-1.40066	.01959	.05167	1.40195	-.96546	.00439	.56E-06
250	.04035	1.74842	.24042	-1.40062	.02252	.04847	1.40164	-.96461	.00423	.57E-06

X FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
251	.01451	1.64092	.20130	-1.40409	.00579	.01669	1.40419	-.97176	.00133	.19E-06
252	.01267	1.74443	.24121	-1.40374	.00703	.01515	1.40384	-.97076	.00131	.16E-06
253	.37344	1.84725	.01741	-.65555	.07557	.11499	1.09001	-.20124	.07431	.75E-05
254	.20594	1.93333	.02571	-1.16147	.40611	.05549	1.27677	-.63526	.04466	.54E-05
255	.35606	1.84725	.05697	-.95473	.50490	.30024	1.15921	-.34377	.06762	.66E-05
256	.14635	1.93333	.03252	-1.21733	.42702	.14663	1.29649	-.68067	.04050	.50E-05
257	.32660	1.84725	.09308	-1.08279	.40358	.37973	1.23755	-.53154	.05616	.63E-05
258	.16022	1.93333	.05133	-1.26361	.33169	.19033	1.32563	-.75728	.03420	.46E-05
259	.29055	1.84725	.11942	-1.16422	.36266	.37229	1.29325	-.67250	.04656	.53E-05
260	.16023	1.93333	.06566	-1.30434	.27994	.19161	1.34776	-.81647	.02820	.39E-05
261	.25362	1.84724	.13955	-1.25465	.26177	.34016	1.33485	-.78162	.03726	.46E-05
262	.13954	1.93333	.07677	-1.33560	.22495	.18116	1.36647	-.86725	.02311	.34E-05
263	.21708	1.84725	.15349	-1.30542	.22460	.29263	1.35465	-.83507	.03024	.41E-05
264	.11971	1.93333	.08491	-1.35761	.16078	.15963	1.37828	-.89964	.01896	.29E-05
265	.18356	1.84725	.16470	-1.33675	.17869	.24887	1.37141	-.88076	.02469	.35E-05
266	.10123	1.93333	.09063	-1.37462	.14575	.13952	1.38935	-.93029	.01572	.24E-05
267	.15524	1.84724	.17168	-1.35769	.14568	.20999	1.38088	-.90683	.02045	.29E-05
268	.08561	1.93333	.09478	-1.38860	.11913	.11974	1.39625	-.94953	.01295	.20E-05
269	.12712	1.84725	.17754	-1.37159	.11541	.17160	1.38710	-.92403	.01657	.23E-05
270	.07010	1.93333	.09791	-1.39468	.09508	.09864	1.40140	-.96393	.01049	.16E-05
271	.10100	1.84725	.16176	-1.38489	.08966	.13654	1.39445	-.94450	.01292	.16E-05
272	.05570	1.93333	.10023	-1.40257	.07405	.07990	1.40680	-.97907	.00831	.13E-05
273	.07674	1.84725	.18465	-1.39156	.06672	.10352	1.39702	-.95166	.00979	.14E-05
274	.04232	1.93333	.10165	-1.40661	.05539	.06072	1.40920	-.98586	.00621	.99E-06
275	.05367	1.84724	.18675	-1.39870	.04601	.07255	1.40134	-.96374	.00678	.97E-06
276	.02960	1.93333	.10249	-1.41127	.03678	.04335	1.41247	-.99506	.00444	.68E-06
277	.03155	1.84725	.18798	-1.40062	.02674	.04222	1.40151	-.96422	.00389	.56E-06
278	.01740	1.93333	.10367	-1.41265	.02179	.02479	1.41304	-.99667	.00243	.41E-06
279	.00991	1.84725	.18800	-1.40364	.00827	.01323	1.40313	-.96876	.00121	.18E-06
280	.00546	1.93333	.10401	-1.41467	.00697	.00794	1.41411	-.99972	.00080	.13E-06

Y FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
1	.96869	.04999	.05140	.01304	-1.12817	.00280	1.12820	-.27297	.00118	-.19E-08
2	.96621	.14997	.05127	.04164	-1.12676	.00841	1.12756	-.27138	.00354	-.56E-08
3	.94266	.04999	.15013	.01037	-1.12835	.00668	1.12842	-.27332	.00105	-.16E-08
4	.94030	.14997	.15574	.03139	-1.12723	.02076	1.12786	-.27207	.00319	-.48E-08
5	.86521	.04999	.24644	.00676	-1.12783	.00814	1.12788	-.27211	.00087	-.14E-08
6	.86304	.14997	.24582	.02097	-1.12701	.02452	1.12747	-.27119	.00261	-.43E-08
7	.76924	.04999	.31617	.00440	-1.12761	.00821	1.12765	-.27159	.00078	-.12E-08
8	.76731	.14997	.31537	.01407	-1.12696	.02457	1.12732	-.27085	.00231	-.36E-08
9	.66969	.04999	.36954	.00348	-1.12726	.00798	1.12732	-.27084	.00069	-.11E-08
10	.66821	.14997	.36861	.01040	-1.12673	.02385	1.12703	-.27020	.00206	-.31E-08
11	.57471	.04999	.40765	.00206	-1.12710	.00778	1.12713	-.27042	.00066	-.93E-09
12	.57327	.14997	.40664	.00766	-1.12661	.02314	1.12687	-.26964	.00194	-.28E-08
13	.48598	.04999	.43665	.00260	-1.12691	.00757	1.12693	-.26998	.00062	-.85E-09
14	.48477	.14997	.43496	.00599	-1.12645	.02257	1.12669	-.26943	.00184	-.25E-08
15	.41160	.04999	.45505	.00158	-1.12677	.00739	1.12679	-.26966	.00060	-.80E-09
16	.40997	.14997	.45371	.00475	-1.12636	.02215	1.12659	-.26920	.00179	-.24E-08
17	.33655	.04999	.47036	.00122	-1.12666	.00729	1.12668	-.26941	.00059	-.75E-09
18	.33571	.14997	.46858	.00366	-1.12627	.02161	1.12649	-.26898	.00175	-.22E-08
19	.26741	.04999	.48121	.00092	-1.12654	.00715	1.12657	-.26915	.00056	-.75E-09
20	.26674	.14997	.48000	.00276	-1.12618	.02160	1.12639	-.26875	.00170	-.22E-08
21	.20317	.04999	.48875	.00070	-1.12647	.00710	1.12649	-.26899	.00056	-.71E-09
22	.20266	.14997	.48773	.00209	-1.12611	.02142	1.12631	-.26858	.00169	-.21E-08
23	.14208	.04999	.49442	.00049	-1.12644	.00709	1.12646	-.26891	.00056	-.70E-09
24	.14173	.14997	.49318	.00145	-1.12608	.02129	1.12628	-.26851	.00167	-.21E-08
25	.08352	.04999	.49769	.00028	-1.12642	.00703	1.12644	-.26887	.00055	-.69E-09
26	.08332	.14997	.49645	.00086	-1.12606	.02124	1.12626	-.26846	.00167	-.20E-08
27	.02622	.04999	.49934	.00009	-1.12640	.00705	1.12642	-.26883	.00055	-.69E-09
28	.02616	.14997	.49809	.00025	-1.12605	.02119	1.12625	-.26843	.00166	-.20E-08
29	.98124	.24995	.05101	.00861	-1.12395	.01407	1.12613	-.26817	.00593	-.92E-08
30	.97372	.34993	.05062	.09639	-1.11965	.01979	1.12396	-.26329	.00834	-.13E-07
31	.93556	.24995	.15495	.05242	-1.12493	.03473	1.12666	-.26941	.00534	-.80E-08
32	.92839	.34992	.15377	.07371	-1.12145	.04879	1.12493	-.26546	.00751	-.11E-07
33	.85868	.24995	.24458	.03510	-1.12533	.04100	1.12662	-.26927	.00437	-.71E-08
34	.85211	.34992	.24271	.04937	-1.12275	.05768	1.12532	-.26634	.00615	-.97E-08
35	.76344	.24995	.31378	.02460	-1.12565	.04118	1.12667	-.26938	.00389	-.56E-08
36	.75759	.34992	.31138	.03467	-1.12357	.05799	1.12560	-.26698	.00548	-.80E-08
37	.66404	.24995	.36676	.01743	-1.12569	.04001	1.12654	-.26909	.00346	-.52E-08
38	.65975	.34992	.36394	.02462	-1.12392	.05648	1.12561	-.26700	.00491	-.71E-08
39	.57038	.24995	.40459	.01321	-1.12567	.03880	1.12642	-.26862	.00326	-.45E-08
40	.56602	.34992	.40149	.01862	-1.12414	.05474	1.12563	-.26704	.00461	-.62E-08
41	.48232	.24995	.43276	.01002	-1.12560	.03784	1.12628	-.26850	.00309	-.42E-08
42	.47863	.34992	.42945	.01412	-1.12421	.05326	1.12556	-.26688	.00435	-.57E-08
43	.40790	.24995	.45162	.00796	-1.12552	.03715	1.12616	-.26825	.00300	-.39E-08
44	.40473	.34993	.44816	.01122	-1.12424	.05230	1.12551	-.26678	.00423	-.53E-08
45	.33401	.24995	.46651	.00617	-1.12548	.03660	1.12609	-.26809	.00294	-.37E-08
46	.33145	.34992	.46294	.00868	-1.12425	.05154	1.12547	-.26668	.00414	-.50E-08
47	.26539	.24995	.47735	.00465	-1.12540	.03618	1.12599	-.26766	.00285	-.36E-08
48	.26335	.34992	.47392	.00655	-1.12423	.05096	1.12540	-.26652	.00401	-.50E-08
49	.20164	.24995	.48527	.00349	-1.12535	.03584	1.12593	-.26772	.00282	-.35E-08
50	.20009	.34993	.48155	.00472	-1.12420	.05055	1.12535	-.26641	.00396	-.48E-08

Y FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
51	.14101	.24995	[illegible]	.00243	-1.12533	.03562	1.12589	-.26764	.00279	-.34E-08
52	.13993	.34992	.45074	.00338	-1.12421	.05022	1.12533	-.26638	.00393	-.47E-08
53	.06290	.24995	.49374	.00144	-1.12531	.03555	1.12587	-.26759	.00279	-.34E-08
54	.06226	.34993	.49016	.00201	-1.12419	.05005	1.12530	-.26631	.00393	-.46E-08
55	.02603	.24995	.49553	.00042	-1.12530	.03548	1.12586	-.26756	.00278	-.34E-08
56	.02583	.34992	.49176	.00059	-1.12418	.04996	1.12529	-.26627	.00391	-.46E-08
57	.96362	.44990	.05009	.12457	-1.11376	.02560	1.12099	-.25663	.01085	-.16E-07
58	.95084	.54988	.04943	.15325	-1.10601	.03152	1.11702	-.24774	.01339	-.16E-07
59	.91876	.44990	.15217	.09532	-1.11607	.06323	1.12252	-.26004	.00974	-.14E-07
60	.90657	.54988	.15016	.11745	-1.11045	.07764	1.11936	-.25296	.01202	-.16E-07
61	.84326	.44990	.24019	.06398	-1.11923	.07476	1.12354	-.26235	.00798	-.12E-07
62	.83208	.54988	.23700	.07690	-1.11438	.09225	1.12117	-.25703	.00987	-.14E-07
63	.74973	.44990	.30615	.04467	-1.12079	.07514	1.12420	-.26384	.00711	-.10E-07
64	.73978	.54988	.30406	.05543	-1.11708	.09281	1.12230	-.25956	.00880	-.12E-07
65	.65293	.44990	.35017	.03162	-1.12164	.07305	1.12446	-.26442	.00633	-.86E-08
66	.64424	.54988	.35539	.03939	-1.11854	.09034	1.12286	-.26065	.00786	-.10E-07
67	.56014	.44990	.39733	.02413	-1.12211	.07085	1.12460	-.26473	.00596	-.77E-08
68	.55271	.54988	.39206	.02987	-1.11939	.08769	1.12322	-.26162	.00740	-.91E-08
69	.47367	.44990	.42500	.01832	-1.12237	.06916	1.12464	-.26483	.00566	-.71E-08
70	.46738	.54987	.41936	.02267	-1.11966	.08547	1.12334	-.26190	.00700	-.83E-08
71	.46057	.44990	.44551	.01457	-1.12247	.06709	1.12461	-.26475	.00549	-.66E-08
72	.39526	.54988	.43703	.01798	-1.12014	.08392	1.12343	-.26209	.00680	-.77E-08
73	.33401	.44990	.45814	.01127	-1.12256	.06690	1.12461	-.26474	.00538	-.62E-08
74	.32366	.54988	.45206	.01369	-1.12035	.08264	1.12346	-.26220	.00664	-.73E-08
75	.26062	.44990	.46900	.00854	-1.12257	.06616	1.12455	-.26461	.00521	-.62E-08
76	.25716	.54988	.46276	.01051	-1.12044	.08171	1.12346	-.26217	.00643	-.72E-08
77	.19802	.44990	.47655	.00643	-1.12260	.06562	1.12453	-.26457	.00518	-.59E-08
78	.19539	.54988	.47023	.00793	-1.12048	.08107	1.12344	-.26211	.00640	-.69E-08
79	.13848	.44990	.48138	.00441	-1.12261	.06526	1.12451	-.26453	.00512	-.58E-08
80	.13664	.54988	.47548	.00546	-1.12054	.08062	1.12345	-.26213	.00633	-.68E-08
81	.06141	.44990	.48597	.00259	-1.12264	.06495	1.12452	-.26455	.00510	-.57E-08
82	.06032	.54988	.47804	.00322	-1.12056	.08038	1.12345	-.26214	.00632	-.66E-08
83	.02556	.44990	.48608	.00075	-1.12264	.06464	1.12451	-.26453	.00506	-.57E-08
84	.02522	.54988	.48022	.00093	-1.12059	.08020	1.12346	-.26215	.00629	-.66E-08
85	.93526	.64985	.04802	.18255	-1.09027	.03747	1.11200	-.23653	.01602	-.21E-07
86	.91675	.74982	.04706	.21246	-1.06436	.04360	1.10583	-.22287	.01873	-.23E-07
87	.89172	.64985	.14770	.14065	-1.10264	.09297	1.11538	-.24407	.01446	-.18E-07
88	.87408	.74982	.14477	.16346	-1.09261	.10837	1.11027	-.23271	.01694	-.20E-07
89	.81845	.64985	.23312	.09417	-1.10862	.11024	1.11626	-.25050	.01181	-.16E-07
90	.80226	.74982	.22851	.11018	-1.10151	.12697	1.11449	-.24210	.01386	-.17E-07
91	.72767	.64985	.27908	.06626	-1.11249	.11097	1.11997	-.25433	.01053	-.13E-07
92	.71327	.74982	.29316	.07759	-1.10668	.12996	1.11699	-.24766	.01237	-.14E-07
93	.63369	.64985	.34957	.04712	-1.11474	.10610	1.12096	-.25656	.00941	-.12E-07
94	.62115	.74982	.34265	.05525	-1.10991	.12670	1.11649	-.25101	.01106	-.13E-07
95	.54366	.64985	.35564	.03574	-1.11546	.10496	1.12147	-.25770	.00887	-.10E-07
96	.53290	.74982	.37801	.04172	-1.11176	.12311	1.11934	-.25292	.01042	-.11E-07
97	.45973	.64985	.41249	.02710	-1.11660	.10235	1.12181	-.25846	.00839	-.93E-08
98	.45063	.74982	.40433	.03166	-1.11292	.12012	1.11983	-.25403	.00987	-.10E-07
99	.36879	.64985	.43946	.02160	-1.11722	.10053	1.12194	-.25875	.00815	-.86E-08
100	.36110	.74982	.42174	.02526	-1.11357	.11660	1.12009	-.25460	.00958	-.93E-08

Y FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
101	.31855	.64965	.44460	.01667	-1.11754	.09913	1.12205	-.25900	.00799	-.81E-08
102	.31255	.74962	.45300	.01951	-1.11404	.11626	1.12020	-.25498	.00936	-.87E-08
103	.25295	.64965	.45520	.01202	-1.11772	.09801	1.12206	-.25906	.00773	-.80E-08
104	.24795	.74962	.44620	.01473	-1.11434	.11497	1.12036	-.25520	.00908	-.85E-08
105	.19219	.64965	.46253	.00950	-1.11766	.09716	1.12212	-.25914	.00767	-.76E-08
106	.18839	.74962	.45336	.01113	-1.11451	.11405	1.12039	-.25527	.00902	-.82E-08
107	.13445	.64965	.46770	.00655	-1.11794	.09656	1.12212	-.25915	.00756	-.75E-08
108	.13175	.74962	.45845	.00766	-1.11467	.11345	1.12045	-.25541	.00893	-.80E-08
109	.07901	.64965	.47080	.00367	-1.11800	.09622	1.12214	-.25920	.00757	-.73E-08
110	.07745	.74962	.46149	.00451	-1.11472	.11305	1.12045	-.25541	.00891	-.78E-08
111	.02461	.64965	.47236	.00115	-1.11800	.09613	1.12212	-.25916	.00754	-.73E-08
112	.02432	.74962	.46302	.00129	-1.11479	.11276	1.12048	-.25548	.00885	-.76E-08
113	.89515	.84978	.04655	.24335	-1.06969	.04997	1.09835	-.20638	.02160	-.24E-07
114	.87019	.94974	.04524	.27515	-1.05256	.05666	1.08921	-.18636	.02468	-.24E-07
115	.85347	.84978	.14136	.13755	-1.06104	.12455	1.10424	-.21934	.01955	-.21E-07
116	.82968	.94974	.13742	.21260	-1.06657	.14112	1.09671	-.20277	.02231	-.21E-07
117	.78335	.84978	.22312	.12662	-1.09277	.14853	1.11009	-.23230	.01602	-.18E-07
118	.76151	.94974	.21676	.14440	-1.08191	.16901	1.10451	-.21994	.01840	-.16E-07
119	.69646	.84978	.26625	.05744	-1.09970	.14992	1.11347	-.23961	.01430	-.15E-07
120	.67704	.94974	.27627	.10199	-1.09098	.17107	1.10901	-.22969	.01639	-.15E-07
121	.60651	.84978	.33458	.06377	-1.10409	.14632	1.11556	-.24448	.01280	-.13E-07
122	.58960	.94974	.32525	.07262	-1.09677	.16710	1.11161	-.23612	.01467	-.13E-07
123	.52034	.84978	.36710	.04840	-1.10652	.14223	1.11667	-.24695	.01207	-.11E-07
124	.50583	.94974	.35681	.05529	-1.10004	.16257	1.11337	-.23958	.01384	-.11E-07
125	.44001	.84978	.39460	.03671	-1.10814	.13886	1.11741	-.24860	.01144	-.10E-07
126	.42774	.94974	.38379	.04260	-1.10222	.15873	1.11439	-.24186	.01311	-.10E-07
127	.37211	.84978	.41200	.02921	-1.10900	.13640	1.11774	-.24935	.01110	-.96E-08
128	.30174	.94974	.40051	.03337	-1.10343	.15600	1.11490	-.24301	.01273	-.95E-08
129	.30471	.84978	.42599	.02249	-1.10971	.13444	1.11805	-.25003	.01086	-.89E-08
130	.29621	.94975	.41372	.02575	-1.10431	.15388	1.11526	-.24364	.01247	-.86E-08
131	.24210	.84978	.43568	.01709	-1.11010	.13296	1.11817	-.25030	.01052	-.88E-08
132	.23535	.94974	.42353	.01944	-1.10490	.15219	1.11550	-.24434	.01208	-.86E-08
133	.18395	.84978	.44269	.01266	-1.11039	.13166	1.11827	-.25053	.01045	-.84E-08
134	.17882	.94974	.43035	.01469	-1.10526	.15096	1.11562	-.24460	.01199	-.82E-08
135	.12864	.84978	.44764	.00866	-1.11057	.13108	1.11832	-.25063	.01032	-.82E-08
136	.12505	.94975	.43516	.01006	-1.10554	.15010	1.11573	-.24485	.01186	-.80E-08
137	.07562	.84978	.45061	.00525	-1.11069	.13067	1.11836	-.25073	.01032	-.80E-08
138	.07352	.94974	.43805	.00594	-1.10569	.14956	1.11577	-.24495	.01183	-.78E-08
139	.02374	.84978	.45210	.00155	-1.11071	.13052	1.11835	-.25072	.01026	-.80E-08
140	.02308	.94974	.43949	.00173	-1.10578	.14930	1.11581	-.24504	.01178	-.76E-08
141	.84159	1.04970	.04375	.30811	-1.03068	.06335	1.07780	-.16165	.02792	-.24E-07
142	.80896	1.14964	.04205	.34213	-1.00501	.07056	1.06400	-.13209	.03139	-.22E-07
143	.80241	1.04970	.13770	.23966	-1.04868	.15876	1.08743	-.18250	.02526	-.21E-07
144	.77130	1.14964	.12775	.26669	-1.02729	.17695	1.07604	-.15766	.02849	-.19E-07
145	.73643	1.04970	.20977	.16360	-1.06852	.19076	1.09759	-.20470	.02090	-.18E-07
146	.70793	1.14964	.20154	.18269	-1.05191	.21393	1.08891	-.18572	.02369	-.17E-07
147	.65479	1.04970	.26912	.11540	-1.08039	.19354	1.10364	-.21862	.01870	-.15E-07
148	.62449	1.14964	.25669	.12975	-1.06685	.21764	1.09656	-.20245	.02116	-.13E-07
149	.57022	1.04970	.31456	.08244	-1.08768	.18943	1.10732	-.22615	.01669	-.13E-07
150	.54811	1.14964	.30256	.09243	-1.07654	.21364	1.10146	-.21321	.01899	-.11E-07

Y FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
151	.40921	1.04970	.34751	.03271	-1.07215	.18445	1.10939	-.23075	.01580	-.11E-07
152	.47024	1.14964	.33356	.07069	-1.06190	.20825	1.10468	-.21900	.01793	-.96E-08
153	.41363	1.34970	.31113	.04753	-1.09409	.16020	1.11065	-.23353	.01494	-.97E-08
154	.39765	1.14964	.35677	.05372	-1.08502	.20367	1.10586	-.22293	.01700	-.85E-08
155	.34965	1.04970	.30735	.05777	-1.09640	.17717	1.11134	-.23508	.01453	-.89E-08
156	.33629	1.14964	.37233	.04200	-1.08765	.20031	1.10677	-.22493	.01650	-.77E-08
157	.26647	1.04970	.40012	.02911	-1.09767	.17476	1.11186	-.23627	.01420	-.82E-08
158	.27537	1.14964	.38401	.03208	-1.08923	.19760	1.10749	-.22654	.01616	-.71E-08
159	.22762	1.04970	.40961	.02209	-1.09644	.17288	1.11217	-.23693	.01375	-.80E-08
160	.21879	1.14964	.39373	.02457	-1.09027	.19550	1.10794	-.22753	.01564	-.66E-08
161	.17294	1.04970	.41626	.01606	-1.09897	.17145	1.11239	-.23740	.01366	-.76E-08
162	.16624	1.14964	.40607	.01878	-1.09093	.19399	1.10820	-.22811	.01554	-.64E-08
163	.12094	1.04970	.42036	.01149	-1.09927	.17051	1.11247	-.23759	.01350	-.74E-08
164	.11625	1.14964	.40939	.01291	-1.09139	.19296	1.10839	-.22853	.01537	-.63E-08
165	.07110	1.04970	.42305	.00678	-1.09950	.16999	1.11259	-.23765	.01349	-.72E-08
166	.06834	1.14964	.40723	.00762	-1.09165	.19233	1.10849	-.22875	.01536	-.61E-08
167	.02232	1.04970	.42555	.00196	-1.09956	.16969	1.11256	-.23764	.01343	-.72E-08
168	.02146	1.14964	.40857	.00219	-1.09161	.19198	1.10856	-.22890	.01528	-.60E-08
169	.77179	1.24957	.04012	.37755	-.97322	.07757	1.04676	-.09571	.03519	-.20E-07
170	.72939	1.34948	.03731	.41396	-.93392	.06538	1.02511	-.05085	.03937	-.16E-07
171	.73587	1.24957	.12165	.29590	-1.00051	.19656	1.06170	-.12722	.03210	-.17E-07
172	.69544	1.34948	.11516	.32665	-.90606	.21690	1.04341	-.08670	.03606	-.13E-07
173	.67540	1.24957	.19236	.20426	-1.03115	.23667	1.07799	-.16206	.02672	-.15E-07
174	.63829	1.34948	.16161	.22757	-1.00474	.26610	1.06396	-.13201	.03017	-.11E-07
175	.60049	1.24957	.24601	.14551	-1.05000	.24422	1.08780	-.16331	.02401	-.11E-07
176	.56749	1.34948	.23325	.16267	-1.02812	.27339	1.07621	-.15823	.02717	-.83E-08
177	.52293	1.24957	.26847	.10448	-1.06225	.24012	1.09405	-.19694	.02149	-.95E-08
178	.49420	1.34948	.27262	.11711	-1.04362	.26974	1.08426	-.17562	.02444	-.65E-08
179	.44864	1.24957	.31823	.07946	-1.06924	.23449	1.09753	-.20456	.02037	-.77E-08
180	.42349	1.34948	.30075	.08912	-1.05230	.26383	1.08652	-.18468	.02313	-.50E-08
181	.37938	1.24957	.34039	.06028	-1.07376	.22956	1.09966	-.20929	.01928	-.67E-08
182	.35853	1.34948	.32169	.06700	-1.05819	.25860	1.09143	-.19121	.02196	-.40E-08
183	.32034	1.24957	.35522	.04769	-1.07637	.22567	1.10086	-.21169	.01875	-.59E-08
184	.30321	1.34948	.33570	.05373	-1.06136	.25455	1.09276	-.19417	.02118	-.33E-08
185	.26272	1.24957	.36694	.03699	-1.07837	.22268	1.10179	-.21394	.01834	-.53E-08
186	.24828	1.34948	.34678	.04175	-1.06368	.25131	1.09396	-.19674	.02091	-.27E-08
187	.20574	1.24957	.37564	.02758	-1.07975	.22056	1.10240	-.21529	.01777	-.50E-08
188	.19728	1.34948	.35500	.03161	-1.06559	.24806	1.09472	-.19842	.02024	-.24E-08
189	.15860	1.24957	.38169	.02111	-1.08056	.21866	1.10271	-.21596	.01766	-.46E-08
190	.14989	1.34948	.36072	.02377	-1.06606	.24706	1.09536	-.19980	.02012	-.21E-08
191	.11091	1.24957	.38595	.01457	-1.08119	.21770	1.10299	-.21658	.01746	-.45E-08
192	.10462	1.34948	.36475	.01640	-1.06754	.24570	1.09557	-.20028	.01989	-.19E-08
193	.06520	1.24957	.38851	.00854	-1.08154	.21706	1.10314	-.21693	.01746	-.43E-08
194	.06162	1.34948	.36717	.00964	-1.06808	.24491	1.09584	-.20088	.01986	-.18E-08
195	.02047	1.24957	.38960	.00256	-1.08173	.21670	1.10323	-.21711	.01737	-.43E-08
196	.01935	1.34948	.36935	.00281	-1.06850	.24457	1.09594	-.20109	.01977	-.18E-08
197	.66077	1.44936	.03539	.45106	-.86430	.09273	.99701	.00596	.04407	-.10E-07
198	.62447	1.54919	.03246	.48707	-.81935	.10034	.95846	.08135	.04946	-.20E-08
199	.64908	1.44936	.10751	.35918	-.92383	.23862	1.01951	-.03940	.04055	-.84E-08
200	.59540	1.54919	.09861	.39240	-.86610	.26056	.98591	.02799	.04578	-.14E-08

Y FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
201	.59574	1.44936	[illegible]	.25261	-.96967	.29538	1.04467	-.09133	.03414	-.65E-06
202	.54647	1.54919	.15566	.20509	-.92220	.32743	1.01790	-.03611	.03690	.33E-09
203	.52966	1.44936	.21770	.16198	-.97603	.30542	1.00021	-.12466	.03085	-.40E-08
204	.48586	1.54919	.17969	.20355	-.95656	.34165	1.03770	-.07698	.03529	.20E-06
205	.46126	1.44936	.25445	.15162	-1.01839	.30264	1.07655	-.14606	.02782	-.23E-08
206	.42311	1.54919	.23346	.11672	-.98351	.34055	1.05137	-.10539	.03197	.34E-06
207	.39572	1.44936	.26070	.10066	-1.02965	.29683	1.07630	-.15842	.02636	-.11E-06
208	.36300	1.54919	.25749	.11361	-.99771	.33533	1.05667	-.12078	.03034	.43E-08
209	.33463	1.44936	.30024	.07637	-1.03714	.29154	1.08004	-.16649	.02506	-.19E-09
210	.30696	1.54919	.27542	.06650	-1.00757	.33017	1.06380	-.13167	.02887	.50E-08
211	.26300	1.44936	.31332	.06074	-1.04141	.26738	1.08204	-.17061	.02419	.39E-09
212	.25959	1.54919	.28741	.06916	-1.01330	.32575	1.06662	-.13767	.02763	.56E-08
213	.23173	1.44936	.32365	.04764	-1.04406	.28361	1.08357	-.17413	.02356	.85E-09
214	.21257	1.54919	.29569	.05565	-1.01768	.32205	1.06684	-.14241	.02719	.59E-08
215	.16412	1.44936	.33133	.03669	-1.04709	.28111	1.08479	-.17676	.02312	.12E-08
216	.16869	1.54919	.30393	.04264	-1.02092	.32933	1.07054	-.14607	.02665	.62E-08
217	.13989	1.44936	.33667	.02736	-1.04860	.27925	1.08549	-.17829	.02299	.14E-08
218	.12332	1.54919	.30833	.03169	-1.02319	.31747	1.07179	-.14873	.02646	.63E-06
219	.09783	1.44936	.34043	.01666	-1.04964	.27600	1.08619	-.17960	.02274	.16E-06
220	.08974	1.54919	.31228	.02266	-1.02462	.31622	1.07273	-.15075	.02620	.65E-08
221	.05751	1.44936	.34267	.01091	-1.05040	.27719	1.08641	-.16029	.02271	.17E-08
222	.05275	1.54919	.31435	.01296	-1.02575	.31543	1.07324	-.15164	.02616	.65E-08
223	.01806	1.44936	.34365	.00333	-1.05097	.27602	1.08082	-.16118	.02259	.16E-06
224	.01656	1.54919	.31539	.00391	-1.02630	.31504	1.07357	-.15256	.02604	.66E-06
225	.55815	1.64892	.02901	.51912	-.73361	.10728	.90509	.16062	.05579	.87E-08
226	.47761	1.74843	.02463	.53984	-.61534	.11209	.82622	.31736	.06353	.23E-07
227	.53217	1.64892	.06814	.42445	-.70797	.26266	.93660	.11904	.05201	.82E-06
228	.45537	1.74843	.07542	.45056	-.67591	.30161	.86657	.24905	.05990	.21E-07
229	.48844	1.64892	.13913	.30910	-.85555	.30164	.97693	.04171	.04475	.94E-08
230	.41795	1.74843	.11905	.33757	-.75500	.39600	.91721	.15874	.05246	.22E-07
231	.43426	1.64892	.17649	.22745	-.90063	.36207	1.00441	-.00864	.04083	.10E-07
232	.37159	1.74843	.15273	.25247	-.81013	.42706	.94996	.09757	.04825	.22E-07
233	.37813	1.64892	.20662	.16740	-.93245	.38444	1.02239	-.04528	.03714	.11E-07
234	.32360	1.74843	.17851	.16608	-.85026	.43549	.97364	.05203	.04414	.23E-07
235	.32445	1.64892	.23014	.12666	-.95057	.38024	1.03186	-.06473	.03533	.12E-07
236	.27762	1.74843	.19673	.14542	-.87527	.43469	.98812	.02361	.04207	.22E-07
237	.27436	1.64892	.24617	.09656	-.96340	.37569	1.03675	-.07900	.03341	.12E-07
238	.23477	1.74842	.21064	.11364	-.89276	.43169	.99616	.00367	.03934	.23E-07
239	.23202	1.64892	.25669	.06011	-.97118	.37141	1.04286	-.08756	.03225	.13E-07
240	.19854	1.74843	.21982	.09273	-.90311	.42829	1.00361	-.00764	.03846	.23E-07
241	.16999	1.64892	.26537	.06367	-.97708	.36767	1.04596	-.09467	.03169	.13E-07
242	.16258	1.74843	.22767	.07364	-.91142	.42573	1.00665	-.01738	.03793	.23E-07
243	.15096	1.64892	.27166	.04672	-.96138	.36536	1.04831	-.09896	.03107	.13E-07
244	.12918	1.74843	.23245	.05661	-.91730	.42359	1.01197	-.02409	.03722	.23E-07
245	.11470	1.64892	.27603	.03665	-.98422	.36351	1.04984	-.10216	.03089	.13E-07
246	.09815	1.74842	.23626	.04262	-.92131	.42265	1.01426	-.02876	.03696	.22E-07
247	.06021	1.64892	.27942	.02326	-.98608	.36213	1.05077	-.10412	.03057	.13E-07
248	.06864	1.74843	.23684	.02932	-.92409	.42091	1.01586	-.03196	.03660	.23E-07
249	.04715	1.64892	.28037	.01476	-.98725	.36157	1.05142	-.10548	.03054	.13E-07
250	.04035	1.74842	.24092	.01726	-.92571	.42030	1.01600	-.03369	.03056	.22E-07

Y FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
251	.01461	1.64692	.26190	.05456	-.90767	.36094	1.05175	-.10618	.03040	.13E-07
252	.01267	1.74843	.24121	.05521	-.92654	.41999	1.01730	-.03490	.03643	.22E-07
253	.37344	1.84725	.01941	.52626	-.44027	.11655	.69680	.51108	.07249	.44E-07
254	.26594	1.93333	.01071	.56767	-.15106	.08358	.40940	.83232	.08456	.71E-07
255	.35606	1.84725	.05997	.45364	-.50856	.30695	.74756	.44115	.06928	.42E-07
256	.19635	1.93333	.03252	.33137	-.20251	.24212	.45755	.79065	.08467	.65E-07
257	.32660	1.84725	.09306	.35572	-.57547	.42064	.61130	.34160	.06195	.42E-07
258	.18022	1.93333	.05133	.26264	-.25569	.34767	.51602	.73372	.08234	.62E-07
259	.29055	1.84725	.11942	.27543	-.66360	.46920	.85812	.26362	.05744	.40E-07
260	.16023	1.93333	.00566	.23467	-.30275	.41238	.56292	.68312	.08238	.55E-07
261	.25362	1.84724	.15955	.21071	-.71600	.49136	.89423	.20036	.05205	.42E-07
262	.13954	1.93333	.07697	.17506	-.35609	.45192	.59635	.64436	.08086	.53E-07
263	.21708	1.84725	.15398	.16927	-.74994	.49600	.91524	.16233	.04911	.42E-07
264	.11971	1.93333	.08491	.16236	-.36097	.47560	.61691	.61696	.08068	.50E-07
265	.18356	1.84725	.10470	.15579	-.77447	.49806	.93107	.13310	.04716	.41E-07
266	.10123	1.93333	.09063	.13397	-.37856	.49251	.63547	.59618	.08065	.47E-07
267	.15524	1.84724	.17138	.11145	-.78997	.49867	.94093	.11466	.04613	.40E-07
268	.08561	1.93333	.09476	.11218	-.36999	.50244	.64585	.58268	.08013	.46E-07
269	.12712	1.84725	.17754	.08968	-.80228	.49903	.94901	.09938	.04547	.39E-07
270	.07010	1.93333	.09791	.09125	-.39910	.51024	.65418	.57205	.08051	.45E-07
271	.10100	1.84725	.10176	.06860	-.81138	.49900	.95502	.08793	.04460	.36E-07
272	.05570	1.93333	.10023	.07141	-.40596	.51619	.66054	.56309	.08052	.44E-07
273	.07674	1.84725	.10466	.05128	-.81746	.49861	.95900	.08032	.04442	.37E-07
274	.04232	1.93333	.10185	.05374	-.42074	.52024	.66501	.55776	.08036	.43E-07
275	.05367	1.84724	.10675	.03466	-.82180	.49861	.96180	.07483	.04384	.36E-07
276	.02960	1.93333	.10299	.03513	-.41369	.52279	.66789	.55392	.08031	.43E-07
277	.03155	1.84725	.10778	.02036	-.82439	.49841	.96356	.07156	.04362	.37E-07
278	.01740	1.93333	.10367	.02213	-.41594	.52439	.66969	.55151	.08048	.42E-07
279	.00991	1.84725	.10860	.00623	-.82563	.49827	.96435	.07003	.04346	.36E-07
280	.00546	1.93333	.10401	.00690	-.41693	.52522	.67062	.55026	.08044	.42E-07

Z FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
1	.93869	.04999	.05140	.49337	.00624	-2.36243	2.43339	-4.92137	.04429	-.30E-05
2	.96621	.14997	.05127	.49470	.01692	-2.36264	2.43353	-4.92206	.04425	-.30E-05
3	.94266	.04999	.15613	1.13378	.01517	-1.71191	2.05348	-3.21677	.11993	-.81E-05
4	.94030	.14997	.15574	1.15262	.04539	-1.71259	2.05385	-3.21832	.11990	-.81E-05
5	.86521	.04999	.24644	1.25000	.01765	-1.06518	1.64494	-1.70563	.15702	-.90E-05
6	.86364	.14997	.24582	1.25515	.05403	-1.06619	1.64570	-1.70832	.15696	-.90E-05
7	.76924	.04999	.31617	1.10047	.01526	-.66957	1.28629	-.65969	.17793	-.10E-04
8	.76731	.14997	.31557	1.09994	.05451	-.67071	1.28945	-.66269	.17786	-.10E-04
9	.66989	.04999	.30954	.93379	.01751	-.42329	1.02540	-.05145	.18651	-.96E-05
10	.66821	.14997	.30761	.93348	.05356	-.42435	1.02680	-.05433	.18645	-.96E-05
11	.57471	.04999	.40766	.77564	.01712	-.27352	.82263	.32327	.19325	-.10E-04
12	.57327	.14997	.40664	.77533	.05165	-.27443	.82409	.32068	.19323	-.10E-04
13	.48598	.04999	.43605	.63700	.01655	-.17759	.66150	.56242	.19582	-.10E-04
14	.48477	.14997	.43496	.63578	.05065	-.17853	.66327	.56007	.19576	-.10E-04
15	.41160	.04999	.45505	.52616	.01639	-.11940	.54174	.70652	.19796	-.10E-04
16	.40997	.14997	.45371	.52800	.04949	-.12028	.54378	.70430	.19792	-.10E-04
17	.33655	.04999	.47066	.42003	.01581	-.07531	.42702	.81765	.19997	-.10E-04
18	.33571	.14997	.46858	.41966	.04846	-.07614	.42945	.81557	.19994	-.10E-04
19	.26741	.04999	.46121	.32773	.01618	-.04504	.33128	.89025	.19817	-.95E-05
20	.26674	.14997	.46000	.32706	.04793	-.04647	.33439	.88818	.19812	-.95E-05
21	.20317	.04999	.46695	.24963	.01584	-.02597	.25088	.93706	.19980	-.97E-05
22	.20266	.14997	.46773	.24609	.04762	-.02677	.25486	.93505	.19977	-.97E-05
23	.14208	.04999	.49442	.17510	.01610	-.01270	.17630	.96892	.19965	-.96E-05
24	.14173	.14997	.49718	.17453	.04754	-.01345	.18138	.96710	.19962	-.96E-05
25	.08352	.04999	.49769	.10324	.01577	-.00444	.10453	.98907	.20066	-.97E-05
26	.08332	.14997	.49645	.10336	.04742	-.00525	.11384	.98704	.20061	-.97E-05
27	.02622	.04999	.49934	.03040	.01573	-.00051	.03423	.99883	.20033	-.96E-05
28	.02616	.14997	.49869	.03034	.04735	-.00130	.05625	.99684	.20030	-.96E-05
29	.98124	.24995	.05101	.49355	.03158	-2.38249	2.43377	-4.92325	.04421	-.30E-05
30	.97372	.34993	.05062	.49170	.04416	-2.38325	2.43385	-4.92361	.04412	-.30E-05
31	.93556	.24995	.15475	1.13053	.07653	-1.71416	2.05482	-3.22230	.11974	-.80E-05
32	.92839	.34992	.15377	1.12692	.10722	-1.71635	2.05604	-3.22729	.11959	-.80E-05
33	.85868	.24995	.24458	1.23335	.09039	-1.08836	1.64738	-1.71386	.15684	-.90E-05
34	.85211	.34992	.24271	1.23057	.12714	-1.09155	1.64983	-1.72195	.15665	-.90E-05
35	.76344	.24995	.31378	1.09829	.09106	-.67264	1.29111	-.66698	.17776	-.10E-04
36	.75759	.34992	.31138	1.09666	.12860	-.67612	1.29474	-.67634	.17759	-.10E-04
37	.66484	.24995	.30676	.93249	.08861	-.42636	1.02916	-.05918	.18630	-.98E-05
38	.65975	.34992	.30394	.93125	.12567	-.42958	1.03323	-.06756	.18622	-.96E-05
39	.57033	.24995	.40459	.77406	.08622	-.27631	.82697	.31612	.19314	-.10E-04
40	.56602	.34992	.40149	.77371	.12162	-.27933	.83156	.30851	.19302	-.10E-04
41	.48232	.24995	.43276	.63605	.08372	-.16025	.66638	.55594	.19572	-.10E-04
42	.47863	.34992	.42945	.63667	.11674	-.16328	.67252	.54772	.19558	-.10E-04
43	.40790	.24995	.45102	.52707	.08299	-.12211	.54813	.69955	.19784	-.10E-04
44	.40478	.34993	.44816	.52702	.11671	-.12472	.55401	.69307	.19775	-.10E-04
45	.33461	.24995	.46691	.41959	.08123	-.07763	.43441	.81129	.19987	-.10E-04
46	.33145	.34992	.45294	.41969	.11459	-.08044	.44186	.80476	.19976	-.10E-04
47	.26539	.24995	.47756	.32767	.08052	-.04819	.34104	.88369	.19807	-.95E-05
48	.26335	.34992	.47372	.32657	.11357	-.05001	.34944	.87769	.19797	-.95E-05
49	.26164	.24995	.45527	.24633	.07996	-.02843	.26291	.93088	.19970	-.97E-05
50	.20069	.34993	.46155	.24606	.11278	-.03098	.27479	.92449	.19959	-.97E-05

Z FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
51	.14161	.24995	.45069	.17402	.07967	-.01510	.19279	.96283	.19955	-.96E-05
52	.13993	.34992	.46674	.17413	.11213	-.01754	.20785	.95680	.19944	-.96E-05
53	.08290	.24995	.47374	.10324	.07939	-.00606	.13042	.98299	.20057	-.97E-05
54	.08226	.34993	.47616	.10511	.11165	-.00932	.15241	.97677	.20046	-.97E-05
55	.02803	.24995	.49556	.05024	.07925	-.00290	.08489	.99279	.20024	-.96E-05
56	.02583	.34992	.49176	.05044	.11166	-.00537	.11586	.98657	.20014	-.96E-05
57	.96362	.44990	.05069	.40921	.05719	-2.38445	2.43479	-4.92822	.04415	-.31E-05
58	.95084	.54968	.04943	.40565	.07015	-2.38536	2.43535	-4.93091	.04397	-.31E-05
59	.91876	.44990	.15217	1.12227	.13692	-1.71974	2.05823	-3.23631	.11926	-.80E-05
60	.90657	.54968	.15016	1.11011	.17055	-1.72374	2.06060	-3.24607	.11897	-.80E-05
61	.84326	.44990	.24019	1.22676	.16459	-1.09602	1.65328	-1.73332	.15641	-.89E-05
62	.83263	.54968	.23700	1.22102	.20314	-1.10163	1.65747	-1.74721	.15609	-.89E-05
63	.74973	.44990	.30615	1.09301	.16595	-.66034	1.29661	-.68638	.17739	-.10E-04
64	.73973	.54966	.30436	1.09012	.20532	-.66634	1.30445	-.70158	.17707	-.10E-04
65	.65290	.44990	.36017	.92924	.16215	-.43380	1.03825	-.07796	.18605	-.98E-05
66	.64424	.54966	.35539	.92096	.20094	-.43960	1.04541	-.09288	.18577	-.98E-05
67	.56014	.44990	.39733	.77237	.15763	-.28359	.83769	.29828	.19284	-.10E-04
68	.55271	.54968	.37206	.77058	.19509	-.28869	.84569	.28481	.19261	-.10E-04
69	.47307	.44990	.42530	.63413	.15359	-.18604	.67869	.53938	.19545	-.10E-04
70	.46738	.54967	.41936	.63359	.19047	-.19212	.68893	.52537	.19523	-.10E-04
71	.40057	.44990	.44351	.52652	.15145	-.12852	.56274	.68333	.19759	-.10E-04
72	.39526	.54968	.43763	.52532	.18701	-.13338	.57335	.67127	.19741	-.10E-04
73	.32801	.44990	.45614	.41651	.14808	-.08403	.45201	.79568	.19964	-.10E-04
74	.32366	.54968	.45206	.41752	.18391	-.08869	.46476	.78398	.19946	-.10E-04
75	.26062	.44990	.46900	.32705	.14734	-.05429	.36279	.86838	.19783	-.95E-05
76	.25716	.54968	.46278	.32548	.18202	-.05874	.37752	.85748	.19764	-.95E-05
77	.19862	.44990	.47655	.24898	.14598	-.03449	.29067	.91551	.19946	-.97E-05
78	.19537	.54968	.47023	.24799	.18079	-.03897	.30936	.90430	.19929	-.97E-05
79	.13848	.44990	.48138	.17450	.14506	-.02107	.22841	.94763	.19931	-.96E-05
80	.13664	.54968	.47548	.17369	.17990	-.02550	.25136	.93682	.19916	-.96E-05
81	.06141	.44990	.48507	.10313	.14503	-.01274	.17841	.96817	.20033	-.97E-05
82	.06032	.54968	.47504	.10264	.17944	-.01722	.20754	.95693	.20016	-.97E-05
83	.02556	.44990	.48608	.03016	.14404	-.00877	.14821	.97803	.20001	-.96E-05
84	.02522	.54968	.48022	.03052	.17907	-.01322	.18210	.96684	.19984	-.96E-05
85	.93526	.64965	.04862	.48169	.08396	-2.38743	2.43703	-4.93910	.04379	-.30E-05
86	.91676	.74962	.04766	.47690	.09770	-2.38868	2.43778	-4.94276	.04357	-.30E-05
87	.89172	.64965	.14770	1.10649	.20369	-1.72947	2.06429	-3.26131	.11893	-.81E-05
88	.87408	.74962	.14477	1.09873	.23817	-1.73602	2.06826	-3.27771	.11845	-.81E-05
89	.81845	.64965	.23312	1.21566	.24243	-1.10851	1.66251	-1.76393	.15570	-.89E-05
90	.80226	.74962	.22851	1.20700	.28392	-1.11746	1.66919	-1.78618	.15516	-.89E-05
91	.72767	.64965	.29908	1.06554	.24514	-.69365	1.31135	-.71963	.17671	-.99E-05
92	.71327	.74962	.29316	1.07990	.28764	-.70294	1.32025	-.74306	.17624	-.99E-05
93	.63369	.64965	.34957	.92306	.23976	-.44649	1.05356	-.10999	.18549	-.98E-05
94	.62115	.74962	.34265	.91998	.28154	-.45545	1.06445	-.13305	.18507	-.98E-05
95	.54366	.64965	.38504	.70865	.23359	-.29530	.85538	.26833	.19232	-.10E-04
96	.53290	.74962	.37801	.70550	.27365	-.30374	.86783	.24687	.19197	-.10E-04
97	.45973	.64965	.41249	.63118	.22745	-.19826	.69959	.51058	.19500	-.10E-04
98	.45063	.74962	.40433	.63023	.26697	-.20657	.71494	.48887	.19465	-.10E-04
99	.38879	.64965	.43046	.52448	.22400	-.13959	.58714	.65526	.19716	-.10E-04
100	.38110	.74962	.42174	.52226	.26251	-.14708	.60274	.63670	.19688	-.10E-04

Z FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
101	.31836	.64965	.44900	.41619	.22001	-.09405	.46046	.70916	.19923	-.10E-04
102	.31265	.74962	.45508	.41517	.25855	-.10212	.49966	.75034	.19695	-.10E-04
103	.25275	.64965	.45520	.32562	.21627	-.06473	.39731	.64214	.19741	-.95E-05
104	.24795	.74962	.44920	.32357	.25576	-.07162	.41067	.62472	.19712	-.95E-05
105	.19219	.64965	.46253	.24770	.21636	-.04473	.33203	.86976	.19906	-.97E-05
106	.18837	.74962	.45353	.24676	.25418	-.05190	.35604	.87160	.19876	-.97E-05
107	.13440	.64965	.46770	.17567	.21579	-.03125	.27680	.92223	.19893	-.96E-05
108	.13175	.74962	.45645	.17263	.25292	-.03831	.30671	.90470	.19867	-.96E-05
109	.07961	.64965	.47030	.10276	.21456	-.02204	.23926	.94275	.19994	-.97E-05
110	.07745	.74962	.46149	.10257	.25221	-.02993	.27383	.92502	.19966	-.97E-05
111	.02451	.64965	.47256	.03051	.21473	-.01888	.21771	.95260	.19964	-.96E-05
112	.02432	.74962	.46302	.03001	.25150	-.02564	.25460	.93518	.19936	-.96E-05
113	.89515	.84978	.04633	.47063	.11220	-2.39079	2.43925	-4.94994	.04325	-.30E-05
114	.87019	.94974	.04524	.46316	.12672	-2.39308	2.44078	-4.95740	.04301	-.30E-05
115	.85347	.84978	.14136	1.03735	.27350	-1.74440	2.07366	-3.30006	.11777	-.80E-05
116	.82968	.94974	.13742	1.07342	.31003	-1.75463	2.08016	-3.32706	.11702	-.80E-05
117	.78335	.84978	.22312	1.19766	.32615	-1.12879	1.67777	-1.81492	.15453	-.88E-05
118	.76151	.94974	.21670	1.16667	.37092	-1.14245	1.66606	-1.84955	.15425	-.89E-05
119	.69646	.84978	.26625	1.07310	.33060	-.71422	1.33082	-.77107	.17567	-.99E-05
120	.67704	.94974	.27627	1.06438	.37702	-.72800	1.34351	-.80503	.17496	-.98E-05
121	.60651	.84978	.33456	.91511	.32403	-.46614	1.07690	-.15971	.18457	-.97E-05
122	.58960	.94974	.32525	.90911	.36966	-.47948	1.09233	-.19318	.18398	-.97E-05
123	.52034	.84978	.36910	.76146	.31572	-.31384	.88204	.22200	.19151	-.10E-04
124	.50583	.94974	.35561	.75750	.36055	-.32667	.90029	.16949	.19096	-.10E-04
125	.44001	.84978	.39480	.62637	.30632	-.21599	.73079	.46595	.19429	-.10E-04
126	.42774	.94974	.38379	.62426	.35179	-.22632	.75207	.43439	.19379	-.99E-05
127	.37211	.84978	.41200	.52001	.30353	-.15673	.62269	.61226	.19650	-.10E-04
128	.36174	.94974	.40051	.51767	.34630	-.16830	.64532	.58356	.19605	-.10E-04
129	.30471	.84978	.42559	.41291	.29671	-.11120	.52162	.72791	.19858	-.10E-04
130	.29621	.94975	.41572	.41159	.34130	-.12267	.54859	.69905	.19814	-.10E-04
131	.24210	.84978	.43506	.32360	.29503	-.08103	.44601	.80107	.19676	-.95E-05
132	.23535	.94974	.42353	.32112	.33795	-.09197	.47517	.77422	.19632	-.95E-05
133	.16395	.84978	.44209	.24650	.29341	-.06061	.38801	.84945	.19843	-.97E-05
134	.17862	.94974	.43035	.24536	.33556	-.07160	.42167	.82203	.19800	-.97E-05
135	.12864	.84978	.44704	.17279	.29232	-.04709	.34282	.88247	.19633	-.96E-05
136	.12505	.94975	.43516	.17154	.33412	-.05792	.37993	.85565	.19790	-.96E-05
137	.07562	.84978	.45061	.10250	.29129	-.03864	.31114	.90319	.19933	-.97E-05
138	.07352	.94974	.43805	.10151	.33322	-.04941	.35177	.87626	.19890	-.97E-05
139	.02374	.84978	.45210	.03011	.29152	-.03464	.29491	.91303	.19903	-.96E-05
140	.02309	.94974	.43949	.02972	.33257	-.04528	.33676	.88659	.19863	-.96E-05
141	.84159	1.04970	.04375	.45377	.14226	-2.39611	2.44268	-4.96765	.04258	-.30E-05
142	.80896	1.14964	.04265	.44269	.15705	-2.39951	2.44515	-4.97874	.04201	-.29E-05
143	.80241	1.04970	.13270	1.05023	.34907	-1.76730	2.08826	-3.36064	.11599	-.79E-05
144	.77139	1.14964	.12775	1.05570	.36903	-1.76362	2.09641	-3.40333	.11480	-.78E-05
145	.73648	1.04970	.20977	1.17239	.42906	-1.15993	1.70164	-1.89556	.15332	-.89E-05
146	.70793	1.14964	.20164	1.15494	.46958	-1.16163	1.71742	-1.94952	.15263	-.89E-05
147	.65479	1.04970	.26912	1.05402	.42549	-.74553	1.35996	-.84950	.17471	-.10E-04
148	.62940	1.14964	.25564	1.04161	.47961	-.76704	1.37961	-.90333	.17364	-.99E-05
149	.57022	1.04970	.31496	.90165	.42603	-.49534	1.11083	-.23394	.18324	-.97E-05
150	.54811	1.14964	.30230	.89257	.47109	-.51651	1.13401	-.28597	.18280	-.97E-05

Z FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
151	.46621	1.04970	.34751	.75026	.40733	-.34214	.92120	.15128	.19077	-.10E-04
152	.47024	1.14964	.33556	.74515	.40125	-.36203	.94614	.10103	.18995	-.10E-04
153	.41308	1.04970	.37113	.61920	.37900	-.24307	.77573	.39825	.19316	-.99E-05
154	.39765	1.14964	.35077	.61479	.45075	-.26215	.80629	.34989	.19280	-.10E-04
155	.34955	1.04970	.36735	.51411	.39276	-.16259	.67224	.54809	.19582	-.10E-04
156	.33629	1.14964	.37253	.51055	.44459	-.20105	.70623	.50124	.19512	-.10E-04
157	.28647	1.04970	.40012	.40817	.36702	-.13052	.57881	.66498	.19759	-.10E-04
158	.27537	1.14964	.38401	.40590	.43771	-.15443	.61659	.61961	.19728	-.10E-04
159	.22702	1.04970	.40961	.31975	.36307	-.10577	.51007	.73963	.19579	-.94E-05
160	.21879	1.14964	.39373	.31711	.43326	-.12312	.55085	.69656	.19540	-.95E-05
161	.17244	1.04970	.41520	.24409	.36024	-.06529	.45977	.78861	.19746	-.97E-05
162	.16624	1.14964	.40067	.24264	.43014	-.10242	.50406	.74590	.19710	-.97E-05
163	.12094	1.04970	.42000	.17110	.37923	-.07143	.42213	.82181	.19738	-.96E-05
164	.11625	1.14964	.40454	.16734	.42829	-.06826	.46894	.78010	.19699	-.96E-05
165	.07119	1.04970	.42305	.10121	.37758	-.06278	.39621	.84302	.19838	-.97E-05
166	.06834	1.14964	.40723	.10034	.42708	-.07959	.44567	.80120	.19804	-.98E-05
167	.02252	1.04970	.42505	.02976	.37772	-.05870	.38341	.85299	.19813	-.96E-05
168	.02146	1.14964	.40857	.02938	.42033	-.07537	.43394	.81170	.19774	-.97E-05
169	.77179	1.24957	.04012	.42952	.17447	-2.40515	2.44942	-4.99965	.04133	-.29E-05
170	.72959	1.34948	.03791	.41256	.19155	-2.41031	2.45286	-5.01651	.04045	-.28E-05
171	.73587	1.24957	.12158	1.00952	.43269	-1.60198	2.11033	-3.45349	.11367	-.76E-05
172	.69544	1.34948	.11518	.97606	.47844	-1.62603	2.12546	-3.51756	.11175	-.77E-05
173	.67540	1.24957	.17258	1.13327	.52595	-1.20807	1.73792	-2.02035	.15120	-.89E-05
174	.63829	1.34948	.16161	1.10490	.56604	-1.24145	1.76223	-2.10544	.14940	-.88E-05
175	.60049	1.24957	.24601	1.02613	.53816	-.79471	1.40503	-.97411	.17283	-.10E-04
176	.56749	1.34948	.25325	1.00544	.60326	-.83604	1.43600	-1.06362	.17118	-.99E-05
177	.52293	1.24957	.26847	.80190	.53053	-.54321	1.16374	-.35428	.18165	-.97E-05
178	.49420	1.34948	.27262	.80633	.59627	-.57705	1.19961	-.43906	.18066	-.98E-05
179	.44864	1.24957	.31823	.73635	.51835	-.38679	.98006	.03949	.18938	-.10E-04
180	.42399	1.34948	.30075	.72464	.56501	-.41952	1.02144	-.04335	.18806	-.10E-04
181	.37938	1.24957	.34059	.60717	.50899	-.28595	.84232	.29050	.19186	-.10E-04
182	.35853	1.34948	.32169	.59751	.57371	-.31689	.88089	.21342	.19107	-.10E-04
183	.32084	1.24957	.35522	.50530	.50201	-.22449	.74682	.44226	.19461	-.10E-04
184	.30321	1.34948	.35570	.49776	.56768	-.25507	.79693	.36491	.19207	-.97E-05
185	.26272	1.24957	.36699	.40220	.49507	-.17739	.66206	.56167	.19643	-.10E-04
186	.24828	1.34948	.34678	.39920	.56052	-.20762	.71684	.48327	.19575	-.10E-04
187	.20874	1.24957	.37564	.31434	.46966	-.14553	.60006	.63993	.19487	-.95E-05
188	.19728	1.34948	.35500	.31243	.55540	-.17541	.66095	.56315	.19381	-.95E-05
189	.15860	1.24957	.38169	.23997	.46678	-.12492	.55682	.68995	.19662	-.96E-05
190	.14989	1.34948	.36072	.23824	.55018	-.15344	.61687	.61700	.19559	-.98E-05
191	.11091	1.24957	.38595	.16850	.46430	-.11009	.52446	.72494	.19649	-.96E-05
192	.10462	1.34948	.36475	.16742	.54662	-.13892	.59018	.65169	.19550	-.96E-05
193	.06520	1.24957	.38851	.09674	.46288	-.10122	.50316	.74683	.19758	-.98E-05
194	.06162	1.34948	.36717	.09862	.54631	-.12962	.57011	.67498	.19660	-.98E-05
195	.02047	1.24957	.38930	.02999	.46177	-.09693	.49234	.75760	.19723	-.97E-05
196	.01935	1.34948	.36838	.02906	.54520	-.12523	.56015	.68623	.19626	-.97E-05
197	.68077	1.44936	.03539	.39149	.20894	-2.41708	2.45747	-5.03918	.03942	-.27E-05
198	.62447	1.54919	.03246	.36410	.22607	-2.42404	2.46242	-5.06353	.03801	-.26E-05
199	.64908	1.44936	.10751	.93465	.52666	-1.85508	2.14365	-3.59523	.10927	-.75E-05
200	.59540	1.54919	.09861	.87971	.57676	-1.89570	2.16800	-3.70023	.10596	-.73E-05

Z FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
201	.59574	1.44936	.15709	1.05665	.65216	-1.20566	1.79460	-2.22080	.14696	-.67E-05
202	.54647	1.54919	.15566	1.01650	.72363	-1.34394	1.83499	-2.30720	.14366	-.85E-05
203	.52966	1.44936	.21770	.77566	.67590	-.87646	1.47705	-1.16167	.16897	-.96E-05
204	.46506	1.54919	.17969	.79024	.75749	-.93969	1.52999	-1.34065	.16589	-.97E-05
205	.40125	1.44936	.25445	.84678	.67133	-.62267	1.24717	-.55544	.17874	-.97E-05
206	.42311	1.54919	.23346	.81836	.75620	-.68464	1.30620	-.71140	.17601	-.96E-05
207	.39572	1.44936	.28070	.70745	.65911	-.46276	1.07326	-.15169	.18625	-.10E-04
208	.36300	1.54919	.25749	.66541	.74603	-.52257	1.14052	-.30079	.18374	-.10E-04
209	.33463	1.44936	.30024	.56413	.64635	-.35818	.94311	.11054	.18944	-.10E-04
210	.30696	1.54919	.27542	.56574	.75506	-.41666	1.01660	-.03347	.18709	-.99E-05
211	.26300	1.44936	.31352	.46593	.64067	-.29500	.85651	.20639	.19050	-.97E-05
212	.25959	1.54919	.28741	.47410	.72746	-.35213	.93701	.12202	.18669	-.93E-05
213	.23173	1.44936	.32366	.39330	.63418	-.24767	.78633	.38169	.19181	-.97E-05
214	.21257	1.54919	.29669	.35720	.71972	-.30407	.87199	.23963	.18964	-.96E-05
215	.16412	1.44936	.33133	.31279	.62768	-.21565	.73562	.46180	.19241	-.95E-05
216	.16869	1.54919	.30393	.30869	.71435	-.27039	.82360	.32108	.19033	-.95E-05
217	.13989	1.44936	.33667	.23641	.62375	-.19236	.69423	.51805	.19422	-.98E-05
218	.12832	1.54919	.30863	.25246	.70927	-.24652	.78605	.38212	.19219	-.97E-05
219	.09763	1.44936	.34043	.10516	.61919	-.17666	.66474	.55811	.19415	-.96E-05
220	.08974	1.54919	.32226	.16327	.70646	-.23663	.76094	.42097	.19215	-.96E-05
221	.05751	1.44936	.34265	.09655	.61927	-.16774	.64661	.57904	.19522	-.98E-05
222	.05275	1.54919	.31435	.09642	.76445	-.22105	.74458	.44560	.19327	-.98E-05
223	.01866	1.44936	.34363	.02969	.61667	-.16291	.63672	.59204	.19493	-.97E-05
224	.01656	1.54919	.31539	.02919	.70326	-.21630	.73635	.45779	.19300	-.97E-05
225	.55815	1.64892	.02901	.32776	.24194	-2.43578	2.46961	-5.09897	.03596	-.25E-05
226	.47761	1.74843	.02463	.27778	.25317	-2.45164	2.47969	-5.14865	.03299	-.22E-05
227	.53217	1.64892	.05814	.60426	.62692	-1.94845	2.19917	-3.83634	.10131	-.70E-05
228	.45537	1.74843	.07542	.69656	.67010	-2.02477	2.24364	-4.03392	.09416	-.65E-05
229	.48844	1.64892	.13913	.94766	.80209	-1.42540	1.89036	-2.57355	.13886	-.83E-05
230	.41795	1.74843	.11965	.64240	.86067	-1.54766	1.96969	-2.88048	.13122	-.80E-05
231	.43426	1.64892	.17649	.66525	.85074	-1.03006	1.60264	-1.56846	.16137	-.95E-05
232	.37159	1.74843	.15273	.79962	.95211	-1.10862	1.70656	-1.91235	.15402	-.92E-05
233	.37818	1.64892	.20862	.77629	.85651	-.77466	1.39152	-.93633	.17206	-.95E-05
234	.32369	1.74843	.17851	.70993	.97264	-.91758	1.51406	-1.29237	.16535	-.93E-05
235	.32445	1.64892	.23014	.65325	.84954	-.61055	1.23336	-.52122	.17996	-.99E-05
236	.27762	1.74843	.19693	.59647	.97100	-.75021	1.36522	-.86363	.17361	-.97E-05
237	.27436	1.64892	.24617	.54036	.83964	-.50209	1.11786	-.24962	.18212	-.95E-05
238	.23477	1.74842	.21064	.50291	.96494	-.64104	1.26292	-.59497	.17390	-.67E-05
239	.23202	1.64892	.25689	.45777	.83216	-.43715	1.04555	-.09317	.18330	-.92E-05
240	.19854	1.74843	.21982	.42965	.96104	-.57491	1.19925	-.43820	.17749	-.90E-05
241	.16999	1.64892	.26537	.37371	.82573	-.36744	.98570	.02840	.18632	-.95E-05
242	.16258	1.74843	.22707	.35637	.95513	-.52277	1.14362	-.30832	.18055	-.93E-05
243	.15036	1.64892	.27166	.29663	.81976	-.35204	.94020	.11603	.18709	-.94E-05
244	.12918	1.74843	.23296	.27665	.95147	-.46615	1.10406	-.21895	.18154	-.92E-05
245	.11470	1.64892	.27663	.22455	.81571	-.32776	.90732	.17677	.18897	-.96E-05
246	.09815	1.74842	.23626	.21572	.94719	-.40066	1.07467	-.15491	.18346	-.94E-05
247	.08021	1.64892	.27912	.15726	.81319	-.31144	.88467	.21700	.18902	-.95E-05
248	.06864	1.74843	.23864	.14721	.94579	-.44352	1.05494	-.11269	.18364	-.93E-05
249	.04715	1.64892	.28677	.07171	.81153	-.30143	.87054	.24216	.19013	-.97E-05
250	.04035	1.74842	.24042	.06640	.94461	-.43325	1.04281	-.08746	.18476	-.95E-05

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Z FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
251	.01401	[illegible]	[illegible]	[illegible]	.61046	-.29656	.66349	.25439	.18988	-.96E-05
252	.01267	[illegible]	.04121	[illegible]	.54339	-.42805	1.03026	-.07368	.18453	-.94E-05
253	.37344	1.84725	[illegible]	[illegible]	.25022	-2.47920	2.50042	-5.25212	.02641	-.20E-05
254	.20594	1.93333	[illegible]	.10113	.22255	-2.65276	2.66400	-6.09691	.02130	-.13E-05
255	.35606	1.84725	.05897	.55764	.65570	-2.14411	2.31307	-4.35307	.08234	-.57E-05
256	.13635	1.93333	.03252	.27267	.65757	-2.43367	2.53553	-5.42893	.06701	-.61E-05
257	.32680	1.84725	.09366	.67765	.95401	-1.74561	2.09290	-3.38025	.11775	-.73E-05
258	.18022	1.93333	.05133	.34598	.67666	-2.19811	2.39156	-4.71955	.09187	-.69E-05
259	.29055	1.84725	.11942	.65875	1.04119	-1.39968	1.86470	-2.47712	.14056	-.85E-05
260	.16023	1.93333	.06566	.34061	1.00904	-1.97696	2.24154	-4.02451	.11135	-.86E-05
261	.25302	1.84724	[illegible]	.59540	1.00636	-1.15925	1.69663	-1.87854	.15055	-.81E-05
262	.13954	1.93333	.07697	.32359	1.07120	-1.81637	2.13345	-3.55162	.11908	-.86E-05
263	.21768	1.84725	[illegible]	.51764	1.10424	-1.00148	1.57605	-1.49026	.15779	-.82E-05
264	.11971	1.93333	.08491	.26771	1.10669	-1.70405	2.05226	-3.21175	.12550	-.89E-05
265	.16356	1.84725	.16470	.44505	1.11123	-.89390	1.49398	-1.23196	.16275	-.82E-05
266	.10123	1.93333	.09663	.24941	1.12568	-1.62597	1.99339	-2.97359	.12946	-.91E-05
267	.15524	1.84724	.17166	.37574	1.11594	-.82439	1.43063	-1.06392	.16657	-.84E-05
268	.03561	1.93333	.09476	.21468	1.13710	-1.57455	1.95406	-2.81836	.13131	-.90E-05
269	.12712	1.84725	.17754	.30729	1.11347	-.77015	1.38874	-.92860	.16980	-.87E-05
270	.07010	1.93333	.09771	.17866	1.14471	-1.53420	1.92251	-2.69606	.13394	-.93E-05
271	.10160	1.84725	.18176	.24526	1.11260	-.73143	1.35359	-.83303	.17101	-.86E-05
272	.05570	1.93333	.10023	.14269	1.14651	-1.50435	1.89628	-2.60348	.13526	-.93E-05
273	.07674	1.84725	.18458	.10415	1.11237	-.70518	1.32987	-.70855	.17292	-.88E-05
274	.04232	1.93333	.10165	.10667	1.15177	-1.48313	1.88098	-2.53809	.13599	-.93E-05
275	.05367	1.84724	.18675	.12654	1.11113	-.66666	1.31232	-.72218	.17269	-.86E-05
276	.02960	1.93333	.10299	.07663	1.15317	-1.46869	1.86894	-2.49293	.13649	-.93E-05
277	.03155	1.84725	.18798	.07444	1.11037	-.67557	1.30187	-.69466	.17306	-.86E-05
278	.01740	1.93333	.10367	.04548	1.15466	-1.45995	1.86205	-2.46724	.13725	-.94E-05
279	.00991	1.84725	.18800	.02262	1.11045	-.67058	1.29742	-.68331	.17304	-.65E-05
280	.00546	1.93333	.10451	.01422	1.15510	-1.45553	1.85623	-2.45302	.13736	-.94E-05

XYZ POTENTIAL FLOW PROGRAM SECTION 5, VERSION 4

SAMPLE PROBLEM TRIAXIAL ELLIPSOID

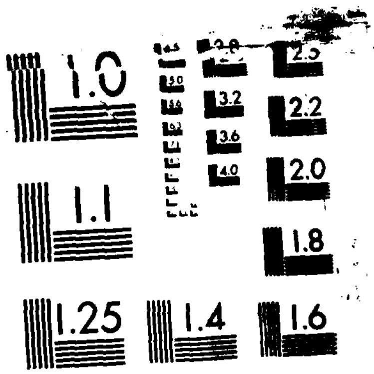
NOBP = 3
IEDITS= 0
IREAD = 0

OFF BODY POINTS

PT.	X	Y	Z
1	2.00000	.00000	.00000
2	.00000	.00000	1.50000
3	.00000	3.00000	.00000

AD-A168 167 FORMULATION OF NUMERICAL METHODS USED IN THE XYZ THREE-DIMENSIONAL POTENT..(U) TEXAS A AND M UNIV COLLEGE STATION COLL OF ENGINEERING W J BEARY MAY 86 3/3

UNCLASSIFIED N00228-85-G-3303 F/G 20/4 NL



MICROCOPY RESOLUTION TEST CHART

SAMPLE PROBLEM TRIAXIAL ELLIPSOID — OFF BODY POINTS — PAGE 1

X FLOW

PT.	X	Y	Z	VX	VY	VZ	CP
1	2.00000	.00000	.00000	-.96173	.00000	.00000	.16668
2	.00000	.00000	1.50000	-1.00024	.00000	.00000	-.16671
3	.00000	3.00000	.00000	-1.02961	.00000	.00000	-.06051

SAMPLE PROBLEM TRIAXIAL ELLIPSOID — OFF BODY POINTS — PAGE 2

Y FLOW

PT.	X	Y	Z	VX	VY	VZ	CP
1	2.00000	.00000	.00000	.00000	-1.03010	.00000	-.06112
2	.00000	.00000	1.50000	.00000	-1.04127	.00000	-.08425
3	.00000	3.00000	.00000	.00000	-.95125	.00000	.09512

SAMPLE PROBLEM TRIAXIAL ELLIPSOID — OFF BODY POINTS — PAGE 3

Z FLOW

PT.	X	Y	Z	VX	VY	VZ	CP
1	2.00000	.00000	.00000	.00000	.00000	-1.10658	-.22452
2	.00000	.00000	1.50000	.00000	.00000	-.76719	.41142
3	.00000	3.00000	.00000	.00000	.00000	-1.05703	-.11731

XYZ POTENTIAL FLOW PROGRAM SECTION 6, VERSION 4

SAMPLE PROBLEM TRIAXIAL ELLIPSOID

2 STREAMLINES TO BE COMPUTED AT 20 STEPS OF -1.0000 T FOR AN ONSET VELOCITY OF .1000 .0000 .0000

STARTING POINTS

PT	X	Y	Z
1	1.00000	1.00000	.00000
2	1.50000	.00000	.00000

STEP 0

LINE	X	Y	Z	VX	VY	VZ	CP
1	1.00000	1.00000	.00000	.05122	-.02290	.00000	.66518
2	1.50000	.00000	.00000	.07772	.00000	.00000	.39600

STEP 1

LINE	X	Y	Z	VX	VY	VZ	CP
1	.95270	1.02485	.00000	.04334	-.02665	.00000	.74008
2	1.42411	.00000	.00000	.07394	.00000	.00000	.45332

STEP 2

LINE	X	Y	Z	VX	VY	VZ	CP
1	.91327	1.05377	.00000	.03565	-.03160	.00000	.77660
2	1.35240	.00000	.00000	.06935	.00000	.00000	.51910

STEP 3

LINE	X	Y	Z	VX	VY	VZ	CP
1	.88110	1.08683	.00000	.02890	-.03506	.00000	.79351
2	1.28576	.00000	.00000	.06378	.00000	.00000	.59326

STEP 4

LINE	X	Y	Z	VX	VY	VZ	CP
1	.85496	1.12394	.00000	.02366	-.03914	.00000	.78987
2	1.22519	.00000	.00000	.05724	.00000	.00000	.67230

STEP 5

LINE	X	Y	Z	VX	VY	VZ	CP
1	.83259	1.16476	.00000	.02107	-.04231	.00000	.77664
2	1.17163	.00000	.00000	.04969	.00000	.00000	.75305

STEP 6

LINE	X	Y	Z	VX	VY	VZ	CP
1	.81250	1.20660	.00000	.01957	-.04567	.00000	.75312
2	1.12610	.00000	.00000	.04126	.00000	.00000	.82956

STEP 7

LINE	X	Y	Z	VX	VY	VZ	CP
1	.79209	1.25559	.00000	.02102	-.04797	.00000	.72574
2	1.08923	.00000	.00000	.03242	.00000	.00000	.84491

STEP 8

LINE	X	Y	Z	VX	VY	VZ	CP
1	.77077	1.39475	.00000	.02174	-.05033	.00000	.69439
2	1.06120	.00000	.00000	.02377	.00000	.00000	.94352

STEP 9

LINE	X	Y	Z	VX	VY	VZ	CP
1	.74064	[illegible]	.00000	.02526	-.05274	.00000	.65504
2	1.04141	.00000	.00000	.01005	.00000	.00000	.97430

STEP 10

LINE	X	Y	Z	VX	VY	VZ	CP
1	.72070	1.41116	.00000	.02702	-.05654	.00000	.60403
2	1.02866	.00000	.00000	.00975	.00000	.00000	.99050

STEP 11

LINE	X	Y	Z	VX	VY	VZ	CP
1	.69033	1.46037	.00000	.03167	-.05806	.00000	.56129
2	1.02135	.00000	.00000	.00526	.00000	.00000	.99724

STEP 12

LINE	X	Y	Z	VX	VY	VZ	CP
1	.65062	[illegible]	.00000	.03753	-.06170	.00000	.47845
2	1.01761	.00000	.00000	.00254	.00000	.00000	.99936

STEP 13

LINE	X	Y	Z	VX	VY	VZ	CP
1	.61701	[illegible]	.00000	.04124	-.06460	.00000	.41959
2	1.01598	.00000	.00000	.00113	.00000	.00000	.99987

STEP 14

LINE	X	Y	Z	VX	VY	VZ	CP
1	.57055	1.65656	.00000	.05008	-.06610	.00000	.31229
2	1.01512	.00000	.00000	.00043	.00000	.00000	.99998

STEP 15

LINE	X	Y	Z	VX	VY	VZ	CP
1	.51694	1.72446	.00000	.06108	-.06935	.00000	.14599
2	1.01480	.00000	.00000	.00020	.00000	.00000	1.00000

STEP 16

LINE	X	Y	Z	VX	VY	VZ	CP
1	.45208	1.79351	.00000	.00864	-.07144	.00000	.01838
2	1.01467	.00000	.00000	.00008	.00000	.00000	1.00000

STEP 17

LINE	X	Y	Z	VX	VY	VZ	CP
1	.37174	1.86222	.00000	.06620	-.06674	.00000	-.18642
2	1.01461	.00000	.00000	.00003	.00000	.00000	1.00000

STEP 18

LINE	X	Y	Z	VX	VY	VZ	CP
1	.27359	1.92997	.00000	.11722	-.04705	.00000	-.54555
2	1.01459	.00000	.00000	.00001	.00000	.00000	1.00000

STEP 19

LINE	X	Y	Z	VX	VY	VZ	CP
1	.15407	1.97074	.00000	.12240	-.03620	.00000	-.62923
2	1.01456	.00000	.00000	.00001	.00000	.00000	1.00000

STEP 20

LINE	X	Y	Z	VX	VY	VZ	CP
1	.02453	1.99669	.00000	.14699	.00103	.00000	-1.16076
2	1.01458	.00000	.00000	.00000	.00000	.00000	1.00000

XYZ POTENTIAL FLOW PROGRAM SECTION 7, VERSION 4

```
SAMPLE PROBLEM TRIAXIAL ELLIPSOID

ON BODY STREAMLINES - INPUT DATA
VXI =  -1.00000
VYI =     .00000
VZI =     .00000
NLIN=         1
JMAX=         0
IWRITE=          1
MACH NO=    .00000

STREAMLINE STARTING POINTS
LINE            X            Y            Z            NSP
  1         1.00000       .05000       .00000          1


SAMPLE PROBLEM TRIAXIAL ELLIPSOID

 UNSET FLOW, VXI=-1.000  VYI=  .000  VZI=  .000

 LINE NO.  1 PASSING THROUGH QUADRILATERAL   1  WITH STARTING POINT,    X=    1.00000  Y=     .05000  Z=     .00000


  I      X        Y        Z        VX        VY       VZ        CP       K1        K2        H2       SL        V       P
  1   .99940   .04999  -.00012   -.01227   .01724   .05798   .99619 -10.55732 -16.67703  1.00000   .00000   .00172*******
  2   .99463   .10000   .01980   -.02990   .03434   .14169   .97785  -3.72831  -5.86713  1.42924   .05404   .14883*******
  3   .99463   .10000   .01980   -.02990   .03434   .14169   .97785  -3.72831  -5.86713  1.42924   .05404   .14883*******
13.27.20.UCLP, AA, NOTTY5A,       2.492KLNS.         ** END OF LISTING **
```

END
DTIC
7-86